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CROSS TALK

► **BITS** . . . Claude Shannon's articles in the *Bell System Technical Journal*, explaining at length the important new concepts on the bandwidth required to transmit intelligence in the presence of noise, are destined to become classics in the literature of communications. While not claiming to have mastered the subtleties of the argument at the present writing, we do want to pass on the new word "bit", a contraction of "binary digit" suggested by J. W. Tukey. Binary digits, or bits, are important because pulse circuits, whether used in pulse code modulation or in electronic computers, are most reliable when they operate, flip-flop fashion, with only two states, on and off. So the discipline of such circuits is most easily analyzed in binary notation. It turns out that a decimal digit is 3.32 bits. Accordingly the value of a twenty-five cent piece, being expressible in two decimal digits, is expressible in 6.64 bits. We thought it was two bits, but we failed to reckon with Shannon and Tukey.

► **DECIMAL** . . . An old-time contributor to this journal, Walther Richter, in a recent speech coined a neat phrase when he said that electrical engineers could be divided into two groups, those working on the right side of the decimal point, and those working on the left. The communications engineer is, very largely, a microwatt-microvolt-microampere man. The power engineer is, in contrast, a kilowatt-kilovolt-kiloampere character. To Mr. Richter's apt division, we would add the group of decimal-point straddlers, the industrial electronic engineers who progress from the right to the left side, taking a microwatt impulse and bringing it to bear on a kilowatt system. These electronic universalists are familiar with the left and the right, and their number grows. More power (megawatts) to them.

► **MKS** . . . The growing acceptance of MKS units in electronic practice is not without important exceptions. The IRE technical committee on electroacoustics has recently discovered that this system of units has, apparently, never been used in the acoustical field and has urged that this omission be rectified forthwith. Fortunately, the conversion from the metric units commonly used to MKS units is accomplished simply in powers of ten. But, unfortunately, there are no simple names for acoustic quantities expressed in these units. The acoustical ohm, for example, is translated literally into emkayess-ese as "joule per stere per stere per second", than which we cannot imagine a less handy term. The committee is now searching for suitable short-form names for MKS acoustic units, and will recommend the same for the forthcoming revised ASA standard terminology on this subject. This is good work. Other committees might well examine their fields for similar omissions.

► **GEO-RESCUE** . . . Some months ago we related the story of the Bell Labs engineer who, lost on the way to a dinner party, was "talked in" to his friend's house through mobile radio installed in his car. Now comes the story of the geophysical exploration party which, roaming over the flatlands searching for suitable test sites, become completely lost. Having explained their predicament to the field office by radio, the members of the party were instructed to explode a charge of dynamite, which they carried for seismic exploration, at a pre-arranged time. The blast, traveling through the earth, was intercepted by a pattern of geophones connected with the field office, while an oscillograph recorded the times of arrival of the shock wave at several locations. A short computation, essentially the loran problem worked backwards, revealed the location of the lost geophysicists. Informed by radio, the party took a bearing for home and got there. Readers will recognize this technique as a solid-land version of the sofar system, which locates ships at sea by precisely the same technique (June, 1948 issue, p 98).

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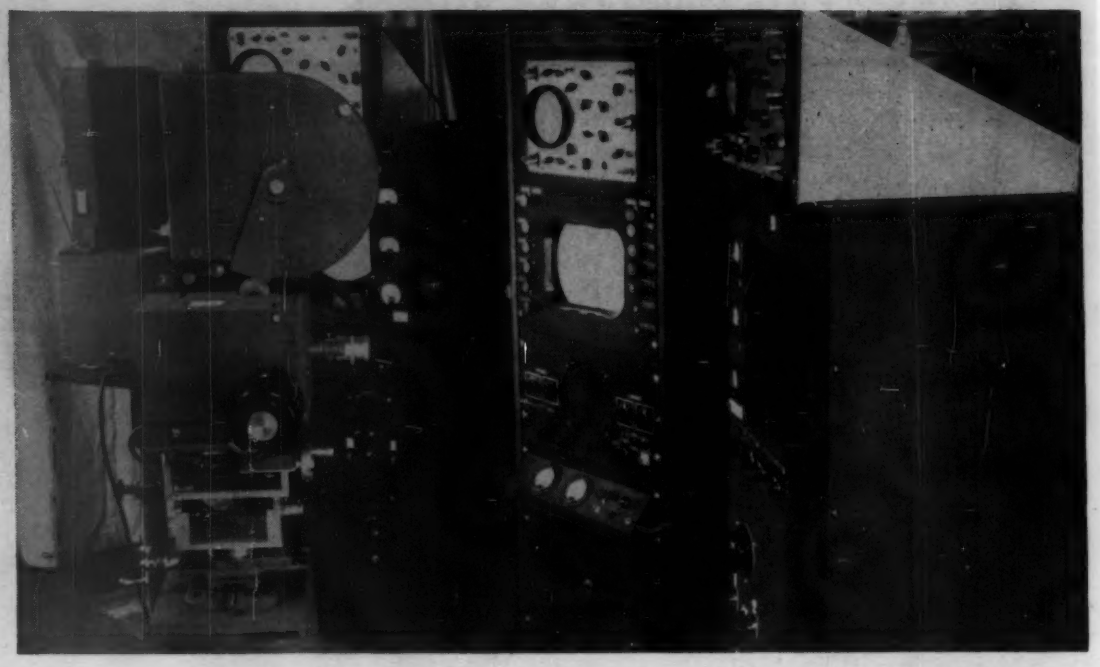

FIG. 1—General view of transcription equipment. Two units are used to provide uninterrupted recording of lengthy programs

TELEVISION

By THOMAS T. GOLDSMITH, JR. and HARRY MILHOLLAND

Director of Research *Senior Engineer*

Allen B. DuMont Laboratories, Inc.
Passaic, New Jersey

FOR MANY YEARS photographic recording has been employed by television engineers to preserve a record of station operation and outstanding programs. The staff of A. B. DuMont Research Dept. has been engaged in studying photographic recording for over ten years. The early efforts used still cameras or nonsynchronous movie cameras which produced results suitable for record purposes. But the quality of such recorded programs was not sufficient for rebroadcast because of insufficient detail and contrast range, as well as stroboscopic-flicker effects caused by lack of synchronization.

With the coming of network television, the need for broadcast-quality photographic transcriptions of television programs has emerged. To meet this need, DuMont Laboratories has developed a transcription system, with the results described in this paper. Teletranscriptions have already proved useful in providing delayed-broadcast network service beyond the limits of coaxial-cable and radio-relay circuits. For this purpose they will undoubtedly serve for many years, until network connections are more widely available and less expensive than at present. Transcriptions also serve many other purposes, such as promotional advertising, as aids to criticism of program techniques and content, and as legal records including documentation of station operation for the records of the FCC. Similar techniques, employing rapid development of film, serve for theater television.

Frame Synchronization

In setting up a teletranscription system, the choice between 35-mm and 16-mm film must be made. Ideally, 35-mm film is to be preferred since it imposes no limitation on the detail of the transcribed image. In practice, however, 16-mm film is preferable on the score of economy, not only in the cost of film stock, but also in the cost and main-

This article is based on a paper presented before the New York Convention of the S.M.P.E., October 1947.

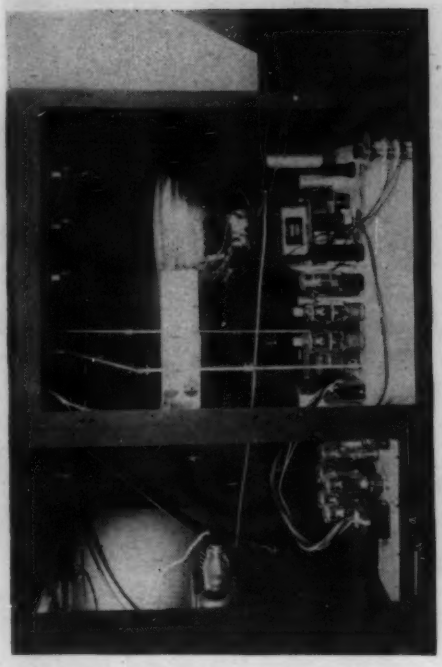

FIG. 2—Monitor with side panel removed to show mechanical arrangement

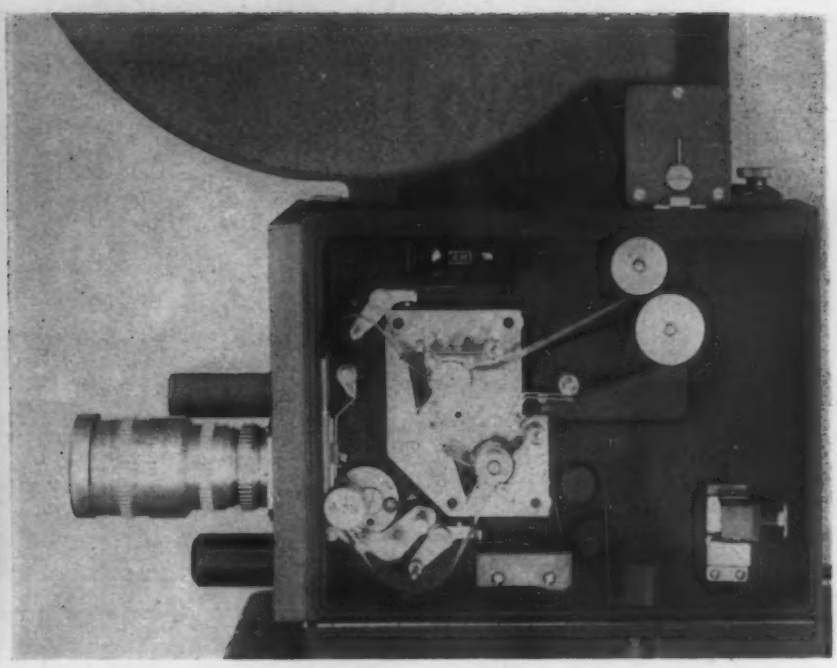

FIG. 3—Side view of the Eastman Kodak model of the camera. A rapid pull-down mechanism moves film between frames in less than 1/120th second

TRANSCRIPTIONS

Recording television images on film, directly from a cathode-ray monitor, preserves programs for rebroadcast, legal records, and network syndication. Broadcast quality is achieved in equipment which transfers from the 30-frame rate of television to the 24-frame movie standard

tenance of the camera equipment. Using fine-grain stock, the film can be exposed and processed so as to retain the full detail of the image. Accordingly, 16-mm equipment was adopted in the equipment described.

An early attempt to solve the frame-synchronization problem resulted in a camera which operated at 15 frames per second, that is, one-half the television frame rate. The exposure time and the pull-down time of this camera were approximately equal, so it photographed one complete television frame and skipped the succeeding one while the film was being pulled down. This system produced a non-standard film which could not be used in standard 24-frame movie projectors. Moreover, the film could not be used for rebroadcast at 30 frames, because of the flicker and discontinuity of motion caused by the missing frames.

This project was abandoned in favor of building a camera which would record directly at 24 frames per second from 30-frame television images. The process is essentially the inverse of the projection system used in televising standard 24-frame film. The 24-frame film may be used in standard 16-mm sound projectors for nontelevision uses, or in television projectors. The prototype camera was constructed. When the princip e was proved, the prototype was taken to the Eastman Kodak Company, which produced a commercial version of the camera.

The sound-recording aspect of teletranscriptions was also a matter requiring attention. Separate sound-on-film recording facilities are employed to assure high quality of reproduction. The two film records, one for picture and the other for sound, are processed separately, using process techniques best suited to each type of recording. The sight and sound portions are combined in a composite 24-frame film. For documentary purposes it may be satisfactory to employ a single camera with sound-recording facilities incorporated in it, the so-called single system, but the processing must then be a compromise between that for best picture and that for best

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sound reproduction quality.

Figure 1 shows a general view of the transcription equipment. Two identical cameras and monitors are used to permit uninterrupted recording if the program lasts more than one-half hour. Each camera has reels which hold 1,200 feet of stock, which allows about 33 minutes of recording. When switching from one monitor-camera to the other, care is taken to assure that the average brightness of the two monitors is closely the same. This measurement is performed with a photographic exposure meter held successively in the same position before the two screens when both carry identical test patterns. Records are kept of power-supply voltages and beam currents in the monitor picture tubes to assure reproducible results from day to day.

FIG. 5—Typical scene as reproduced on 35-mm movie film

Uniform Focus

The monitor circuits and picture tubes have been designed with particular care to remove imperfections that might be tolerated in a home receiver. For example, the high-voltage power supply has excellent regulation to avoid changes in picture size with changes in average brightness. The high-voltage supply is a 25,000-volt unit conservatively operated at 17,000 volts. The monitor picture tube is a 12-inch magnetically-focussed and deflected unit. The area scanned is 6 by 8 inches. This small area assures uniform focus and a flat field. The tubes are conventional, but are carefully selected to have uniform phosphors and good focus over the area scanned.

It is possible to operate the system with negative or positive images on the monitor, but experience has proved the positive image preferable. The film image is then a negative and the composite print (made from the negative picture film and sound film) is a positive. If time is very short, the negative film image may be transmitted without making the composite positive print, merely by reversing the polarity of the television camera output. But the best quality has been found to result consistently from a composite positive print made from a negative.

To assure that the film shall not limit the resolution of the system, very-fine-grain film is used, that is, positive stock ordinarily used for making projection prints. DuPont type 602A has been found highly satisfactory. This film, speed approximately Weston 8, is slow compared with negative stock and reversal film, but it has extremely fine grain and wide latitude. Also, it costs about one third as much as faster films, and this may be a very important factor in an extensive recording project. The same type of film is used for picture negative, sound negative and composite positive. A special processing technique, is used to develop the picture negative. Otherwise the processing is conventional.

To assure adequate exposure using slow film, a bright monitor image and fast lens are required. The image, produced on the 6-by-8-inch rectangle, has a highlight brightness above 100 foot-lamberts. The lens is a standard Kodak camera lens of two-inch focal length and maximum aperture f1.6. The lens is operated at fixed focus of five feet and a fixed aperture of f2. The latter setting is not changed, since it would change the cone of light within the camera and would interfere with the proper operation of the shutter. If any change in the aperture is required, neutral-density filters are placed on the lens as required. Optical resolution of the lens is not critical. Any good

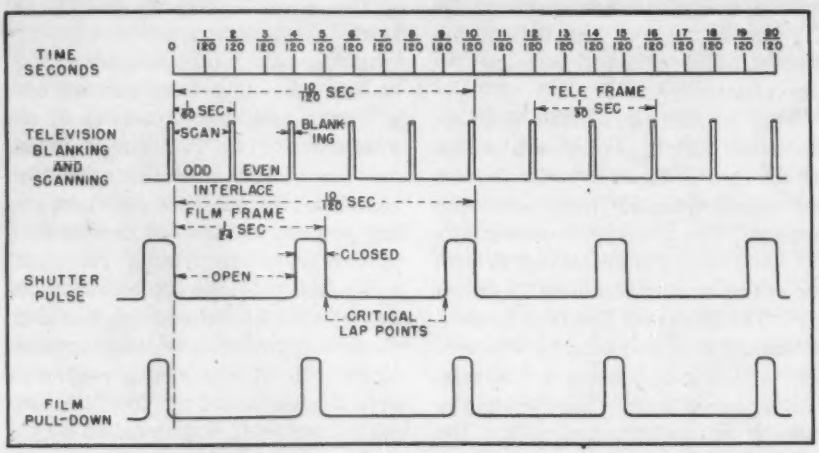

FIG. 4—Time relationships between television signal, shutter and pull-down mechanism. Accurate setting of shutter is essential to avoid overlapping or underlapping exposures

FIG. 6—Televised reproduction of scene shown in Fig. 5

taking lens is satisfactory but projection lens are to be avoided.

Using this optical system and film, the full horizontal resolution of the original television image is preserved in the film. In fact it is possible to identify in the film images the fine-structure noise present in the original television image. The contrast range of the system is likewise limited by the television image, not the film. Using a conventional photographic gray scale of 11 steps between black and white, the monitor has been found capable of rendering 7 steps of gray, plus black and white. The latitude of the film is sufficient to cover this range by a wide margin.

The monitor brightness and contrast controls are adjusted by eye to give the most even rendition of the gray scale, as viewed on the film after processing. This process matches the transfer characteristic of the television system to the gamma characteristic of the film. Electrical gamma-correction circuits are also available in the equipment. Particular care was taken in the design and adjustment of the scanning circuits in the monitor to preserve a high degree of linearity. Figure 2 shows an interior view of the monitor.

The camera employs a rapid pull-down mechanism and a specially designed shutter which exposes two complete fields of television scanning on each frame of motion-picture film. An interior view of this camera is shown in Fig. 3. The shutter closes for exactly one-half of a television field, and the pull-down takes place in something less than one fifth of the complete pull-down-plus-exposure cycle. This cycle occurs at a rate of 24 frames per second, at a shaft speed of 1,440 revolutions per minute.

Sequence of Operation

The timing sequence and phase relationships of the television signal, the blanking cycle of the shutter, and the motion of the film during pull-down are shown in Fig. 4. At the top is a timing indication expressed in intervals of 1/120 second. This interval is a subdivision of both the 30-frame-per-second television-picture interval and the 24-frame-per-second film picture interval. The next line indicates the television blanking interval and the useful television picture interval. Here the television field interval of 1/60 second provides one half of the interlaced picture, and the succeeding 1/60 second field interval provides the other interlaced half. Accordingly, two fields of television scanning constitute one complete frame of television picture in an elapsed time of 1/30 second. On the next line is shown the camera-shutter characteristic, which must be very carefully adjusted. On the bottom line the film pull-down cycle is illustrated.

The most critical characteristic in the recording camera is the timing of the shutter-blanking and exposure interval. The absolute intervals are the most important, and if they are appropriately adjusted the exact phase relationship is not very critical. As shown in Fig. 4, the phase relationship has been so adjusted that one of the points for opening (or closing) the shutter is placed directly under the television blanking interval. The other shutter point occurs approximately in the middle of the television field interval. If this shutter is not adjusted correctly, a bar, caused by overlapping or underlapping exposures, is likely to appear in the recorded film picture. Such a bar is noticeable as a flicker of several lines in the picture.

It is customary to drive a recording camera by synchronous motor. If the television signal and the recording camera are controlled by the same power lines, the camera runs in exact synchronism with the television synchronizing generator. In many cases, however, it is necessary to record programs which have originated in a region beyond the limits of the synchronized power lines. On nonsynchronous power supplies, two regions of overlap may appear and move up or down the picture at a rate equal to the difference frequency between the 60-cycle supply controlling the synchronizing generator and the 60-cycle supply driving the synchronous motor of the camera.

Many films have been recorded in the nonsynchronous manner. To do so successfully it is desirable that the shutter angles be accurately adjusted so that the overlap bars are eliminated. It is better to have a slight overlap, rather than an underlap, to minimize the bar effect.

To show the quality of pictures obtainable, Fig. 5 is a blown-up print of an original photograph taken on 35-mm film, while Fig. 6 is a photograph of the same subject taken from the face of a cathode-ray tube. Very little difference exists between these two photographs.

The motion-picture film compares favorably with the results obtained with a still camera.

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SERRASOID

Design data for an improved four-tube phase-shift type modulator that initiates 100-percent modulation with noise 80 db down and 0.25 percent harmonic distortion in broadcast service. Low relative cost suggests potentially greater utilization of the educational frequencies. Variations of the basic circuit open new fields of application

By J. R. DAY

Radio Engineering Labs., Inc.
Long Island City, N. Y.

THE development of a simple f-m modulator has been one phase of a broad program to enlarge the technical horizons of f-m broadcasting. In particular, it was aimed at providing one solution to the problems of relay and chain broadcasting. Such service requires that the noise background and distortion be very low in the individual links so that the final signal may still meet the relatively high standards required for any f-m broadcasting system. Such chain systems have been operated satisfactorily using available equipment, but it cannot be said that, in the more extensive chains, the limiting noise rests with the audio facilities at the origin. This latter condition has always been regarded as a minimum requirement of a really good f-m broadcast setup.

Careful examination of the problems in a reasonably extensive chain yields the conclusion that an 80 db ratio of 100-percent modulation to noise in the modulator would be satisfactory. In addition, a maximum figure of 0.25-percent harmonic distortion for 100-percent modulation with single tones from 50 to 15,000 cycles was set as a correlative objective. Since a practical modulator involves accessory circuits such as an audio amplifier, which can be expected to make some definite though small contribution to the numbers above, the actual net requirements on the modulation process are somewhat more severe than the overall figures. It is evident that such performance will also be of significant application in a single f-m broadcast setup, apart from the special question of relaying.

Means of generating frequency-modulated currents fall into two general classes, the reactance-modulated type, and the phase-shift type. In the first, the frequency of an oscillator is caused to vary linearly with modulation through the agency of a reactance tube or its equivalent, which is an integral part of the frequency-determining circuit. Because of the modulation and linearity requirement such an oscillator in general is not stable enough for broadcast service. Automatic frequency control is therefore employed. In the phase-shift type of modulator the frequency of the carrier oscillator is not varied, and therefore a stiff control such as a quartz crystal can be used to secure the desired stability, which then is completely independent of the modulation process. Modulation of the frequency in such a system is secured by varying the phase of the frequency-stabilized wave. The frequency will be deviated from its controlled value only during the time the phase is changing, and the deviation, other things being equal, is proportional to the rate of change of phase.

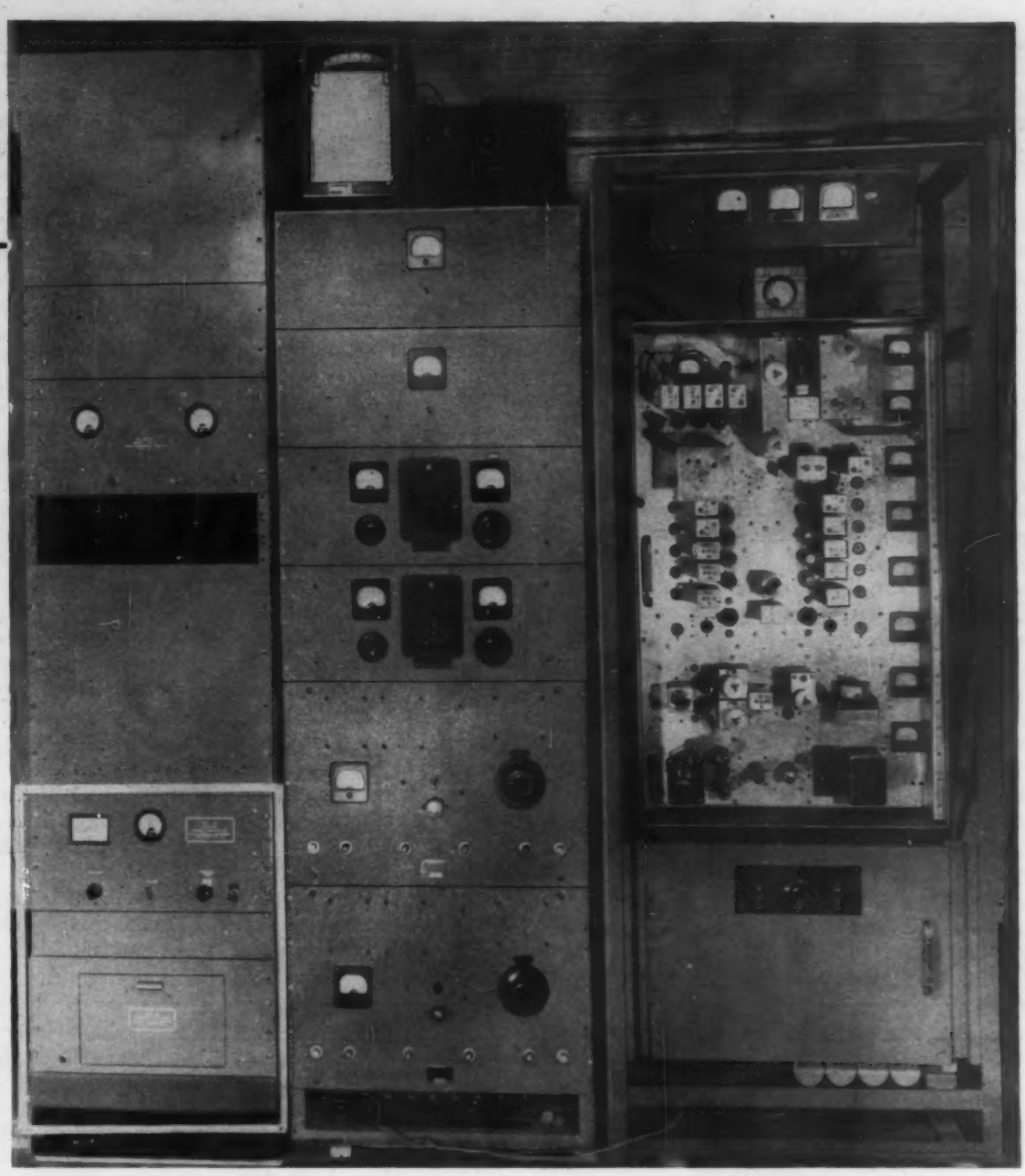
The Serrasoid is the latter type. Although it is capable of broader

The first successful method of producing frequency modulation was the phase-shift method. Despite certain shortcomings in inherent noise, distortion at the lower modulating frequencies, and a tendency of the center frequency to drift, it carried the burden of launching the f-m system successfully.

- **The invention of the double channel modulator, which was brought to a high degree of perfection through the work of John Bose, eliminated these difficulties. It, however, had the commercial disadvantage common to all frequency modulators of requiring a large number of tubes. This disadvantage is not of much importance in transmitters of powers above 1 kw, as the cost of the modulator then becomes a relatively small part of the total. For transmitters of low power, however, the modulator becomes a major item. Herein lies opportunity for great improvement.**
- **I have always felt that the phase-shift method of producing frequency modulation would be the surviving method and that someone some day would overcome its greatest weakness by finding the means of increasing the initial phase-shift without compromising any of the requirements of distortionless noise-free f-m.**
- **This James R. Day has done. Not only has he done it without compromise, but he has in fact improved performance to hitherto unattained levels.**
- **The significance of this development is that by its simplicity and reliability it has opened up all sorts of new broadcasting possibilities. One can visualize the operation of unsupervised transmitters of a few watts power, controlled from pulpits, schoolhouse assembly halls, and similar places, the transmitter requiring no more attention than the common, everyday public address system.**
- **The invention has opened up some amusing possibilities. If, as seems likely, the Serrasoid becomes the accepted method of producing frequency modulation, the phrase-makers who have dubbed the phase-shift method the "indirect method" will find themselves in an awkward situation. Some of us have lived long enough to recall the days when the automobile was referred to as the "horseless carriage."**

—E. H. ARMSTRONG

F-M MODULATOR



Size comparison between the Serrasold modulator (outlined in white) and the original Dual-Channel modulator at the right. Center rack and upper section of left rack are used for other equipment. Photograph taken at the Armstrong f-m broadcast station W2XMN-W2XEA at Alpine, N. J. where the new modulator has been in service for six months

application, the numbers involved for the f-m broadcast case provide the clearest illustrative material. As noted above, frequency deviation is proportional to rate of change of phase. For sinusoidal modulation this is simply expressed by saying that the peak frequency deviation is equal to the product of the peak phase shift and the modulating frequency. The new circuit is conservatively capable of a peak phase shift of ±150 degrees, but ±90 degrees or ±1½ radians is used as the basis for 100-percent modulation at 50 cycles. For 1½ radians and 50 cycles the peak deviation therefore will be ±75 cycles. Since 100-percent modulation in f-m broadcasting is a deviation of ±75,000 cycles, a frequency multiplication of 1,000 is indicated. Actually, 972 is used since it can be factored into a convenient assortment of doublers and triplers. In all that follows we shall discuss a modulator for a frequency of 97.2 megacycles which starts at

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a base frequency of 100 kilocycles.

Figure 1 is a schematic diagram of the essential parts of a complete broadcast Serrasoid. Audio amplifiers and frequency multipliers have been omitted since they are conventional and employ small standard type tubes. Tube V_1 is a pentode oscillator controlled by quartz crystal Y. The crystal operates very close to its series resonant frequency. The net reactance of the crystal arm may be conveniently varied by a series capacitor for fine frequency adjustment of about ± 0.005 percent. This crystal is oven controlled in the broadcast case to a net stability of ± 0.0002 percent, which is also the stability of the final carrier frequency. The operation of the oscillator is such that plate current is drawn only during a small part of the cycle. Negative going pulses shown in Fig. 2A are generated at the plate of V_1. These pulses are differentiated by C_3, R_4, and grid-cathode conductance of V_{2A} to yield still shorter pulses several times the cutoff voltage of V_{2A}. The corresponding short positive pulses at the plate of this latter tube are bottom clipped (to clean the base line) by cathode follower V_{2B}. Resistor R_7 is selected so that this tube is biased beyond cutoff between pulses by the automatic grid bias of C_4 and R_6. The pulses at the cathode of V_{2B} appear as shown in Fig. 2B. The two halves of V_2 perform the functions of a single pentode that might have been used in the same place, with the additional advantage that the final waveform is developed in a lower impedance than is practicable with a pentode.

Linear Sawtooth Wave

According to the numbers of the illustrative case these pulses recur at a rate of 100 kilocycles, that is, corresponding points or events on consecutive pulses are 10 microseconds apart. Tube V_{3A} constitutes a nonoscillatory sawtooth generator timed by the pulses from V_{2B}. The slowly increasing portion of the sawtooth has a slope corresponding to the charging of C_7 through R_{10} to the relatively steady voltage at the junction of R_9 and R_{10}. This period coincides with the time between pulses at the grid of V_{3A}, cutoff bias having been developed on C_5 by previous pulses. The quickly decreasing portion of the sawtooth occurs at the time of positive pulses on V_{3A}, when C_7 is discharged nearly to cathode potential by the plate-cathode conductance. In round numbers the discharge point is about 5 volts from cathode or ground potential and R_{10} and C_7 are adjusted to give a rising rate of about 4 volts per microsecond to the increasing portion of the wave. As will be shown the whole linearity of the modulation process depends on the straightness of this sawtooth wave. In its simple form, it would have too much exponential curvature to be useful. This condition is corrected by the bootstrap connection comprising the cathode follower V_{3B}, R_{11}, C_8, and R_9. The normally constant voltage at the positive end of R_{10} has superimposed upon it the rising voltage on C_7 so that the drop on R_{10} and hence the charging current is maintained practically constant. Resistor R_9, as in other bootstrap applications could be a diode with its anode at plate supply potential, but for the voltage magnitudes involved here the resistor is more than adequate. The d-c voltage at the junction of R_9 and R_{10} is about +190 volts for a B+ value of 250 volts.

Pulses are Frequency-Modulated

The sawtooth wave thus developed is directly coupled to the grid of V_{4A}. This tube is cathode biased by its plate current so that conduction begins when the sawtooth is about half way up; the passage from the beginning of plate current flow to grid current consuming about 0.25 microsecond. Because C_8 is large and holds the bias constant during the sawtooth period, grid current stops the charging of C_7, and the latter half of the sawtooth rise is clipped. The resulting waveform is shown in Fig. 2C the dashed line indicating the waveform without the direct coupling to the grid of V_{4A}. Thus, the plate current of V_{4A} flows only during the

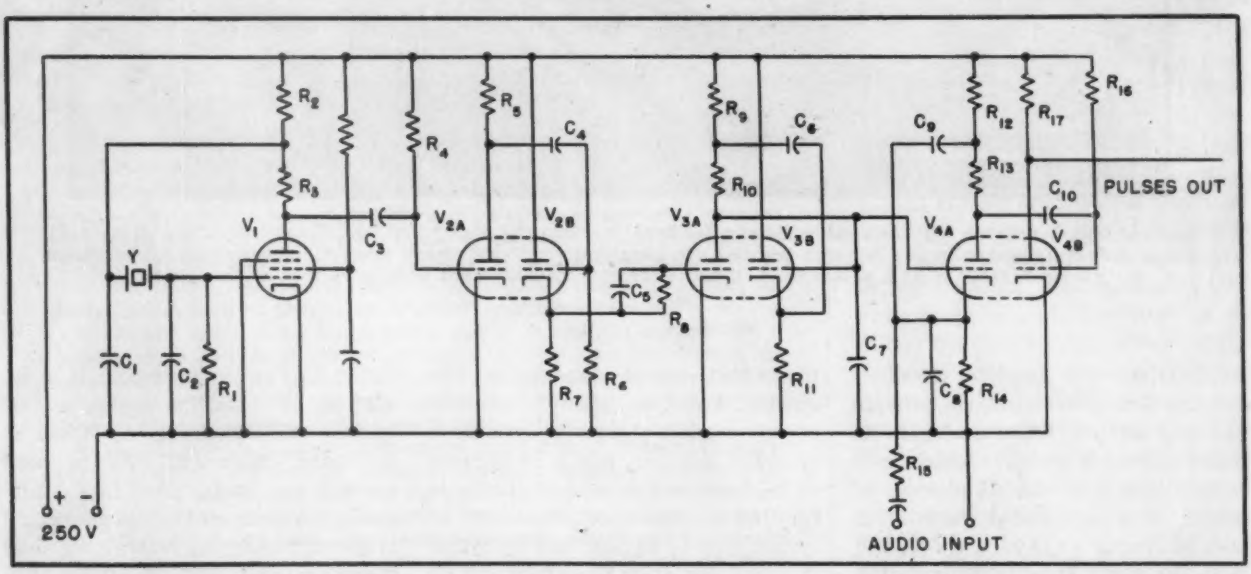

FIG. 1—The modulator proper showing the crystal oscillator, clipper, sawtooth generator and bootstrap cathode follower, and f-m pulse output tubes. The frequency multiplier stages that follow are conventional

latter half of the sawtooth wave. If the bias for V_{4A} is varied, the leading edge of this current pulse will vary in time or phase, an advance resulting from a lowering of the bias and a retardation from an increase. It is in this way that phase modulation in the unit is accomplished.

Audio or program is applied at the indicated terminals. Values of R_{15} and C_8 are so proportioned that for constant audio input amplitude versus frequency, the resulting amplitude at C_8 is inversely proportional to audio frequency over the range upward from 50 cycles. This circuit is included so that the peak phase shift shall be inversely proportional to modulating frequency and the resulting frequency response of the frequency modulation shall be flat. The function and the network are the familiar corrector present in all phase-shift type frequency modulators. In order that at 50 cycles the phase of the pulse edge be shifted $\pm 1\frac{1}{2}$ radians, approximately 50 volts rms is required at the input to the corrector. In the complete modulator a two-stage amplifier provides the gain to raise the standard input of ± 10 dbm to this level. Since feedback is used in this audio amplifier to provide linearity, the effective modulation sensitivity is also stabilized to a marked degree. This sensitivity depends only on the audio gain and the stability of R_{10} and C_7, and ordinarily is stable to within 1 percent for the standard ranges of temperature, line voltage, and tube changes.

Figure 2D illustrates the waveform at the plate of V_{4A}, the dashed lines showing the extreme positions of the leading or negative going edge during 100-percent modulation at 50 cycles. For 100-percent modulation at 100 cycles the excursion is one half that shown, and so on. This wave is differentiated by C_{10}, R_{16}, and the grid cathode conductance of V_{4B} so that the latter is cut off for a short time each cycle beginning at the leading edge. The resulting positive-going pulses at the plate of V_{4B} are shown in Fig. 2E. These pulses are frequency modulated approximately ± 75 cycles at 100-percent modulation. They are applied to the grid of the first of a string of frequency multipliers. The plate

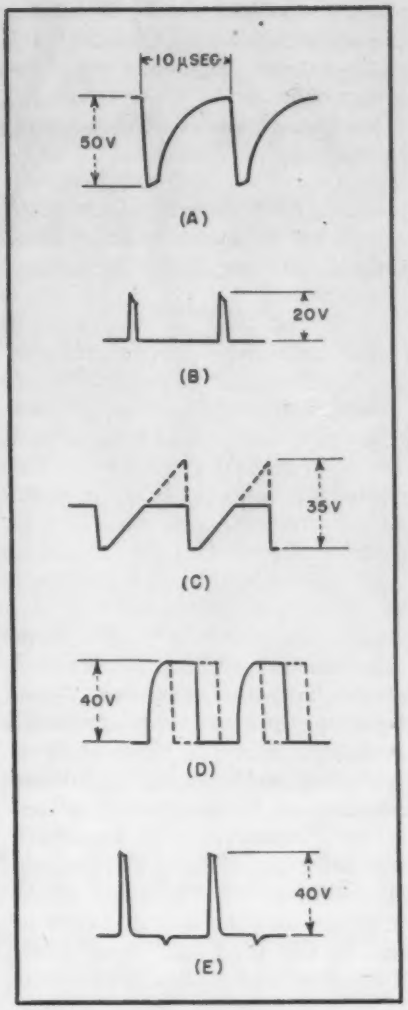

FIG. 2—Waveforms. oscillator to output

loads of this and subsequent multipliers are resonant at the various harmonics, and therefore, involve only sinusoidal c-w currents. In the broadcast version these multiplications are 3, 3, 3, 3, 2, 3, and 2, for a total of 972 times, yielding a carrier frequency in this illustration of 97.2 megacycles with a deviation of ± 75 kilocycles at 100-percent modulation.

Circuit Design Factors

Before proceeding to a discussion of distortion and noise in a system of this sort several salient features may be pointed out. First, in common with all phase-shift modulators, there is no interaction whatever between the functions of modulation and carrier-frequency control, and the final stability is exactly that of well engineered crystal control. Exclusive of the frequency control the modulation process is accomplished in three standard receiving type tubes operating under cutoff to saturation or cathode follower conditions. As a result the process is remarkably independent of tube changes or aging. There are no resonant circuits and no reactances. Largely to eliminate the commercial tolerances of resistors and capacitors, C_3, C_7, C_{10}, and R_{14} are factory adjusted, and thereafter no adjustments even of a maintenance nature are necessary, except after outright component failure. Tubes V_1 through V_4 drain about 20 milliamperes at 250 volts.

Possible Variations

An interesting aspect of the development of this modulator lies in its apparent simplicity. Until certain special factors were fully appreciated performance was indifferent and the simultaneous attainment of low distortion and low noise hardly seemed practical without considerable elaboration. A good many detailed variations from the sample circuit shown are operative, and some yield high performance. But without the observance of certain principles, design can be surprisingly difficult. The important rules affecting linearity and noise are enumerated below.

Having selected the sawtooth waveform as the basic timing or phase-shifting mechanism, it developed that linearity could not be preserved if it was amplified or caused to appear as a current variation in a plate-loaded tube, no matter how attractive such a step may have appeared at first. Other means of straightening the sawtooth beside the bootstrap arrangement shown are entirely practical provided the sawtooth waveshape as such is not amplified. In particular, in the modulation process the tube performing the timing, V_{4A}, cannot carry currents of sawtooth shape and still preserve linearity in the timing process. It was found also that the amplitude of the current pulses in V_{4A} should be constant during the modulation cycle. To insure this condition the plate supply voltage is maintained constant by C_9. The supply voltage is low, about 30 volts, giving a small cutoff voltage.

Noise arises in such a system in the form of random variations in

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the time of occurrence of corresponding events in consecutive cycles. Such timing variations ordinarily are the result of superposition of noise voltages on the desired wave-form. The noise voltages originate either in tube current variations or as Johnson noise in resistors. The effects of both kinds of noise are reduced by increasing the time rate of change of voltage in the sides of the pulses, and by maintaining low circuit impedances at certain points. For instance, impedances controlled by R_6, R_7, and R_{10} are in a position to contribute to the residual modulator noise unless maintained below values appropriate to the pulse amplitudes appearing across them. This is another way of saying that the circuit bandwidth should be as great as possible so that the pulse rise-time is short. Noise originating from uniformly distributed random voltage variations causes frequency modulation noise with a triangular distribution spectrum, extending linearly up from zero at zero modulating frequency. For the band up to 15,000 cycles the integrated noise power from a given resistance is approximately 44 db greater than would be the case for a flat noise spectrum. The 75 microsecond de-emphasis in the f-m receiver reduces this effect by 13 db. The reduction factor is different if the original noise is other than triangular. For instance, Johnson noise in R_{10} is modified in its spectrum by C_7 before it can phase modulate pulses determined by the sawtooth. It is a straightforward matter to show by calculation that if the linearity were secured without the bootstrap or its low-voltage equivalent, that is, by making the supply voltage very high, the noise generated by the necessary large resistor would be excessive by a considerable factor. Thus it comes about that the bootstrap or its low voltage equivalent is uniquely essential to securing simultaneously low noise and low distortion. By similar reasoning it can be shown that the lowest noise is obtained when the corrector capacitor C_5, is directly at the modulator cathode. If the corrector were to be located at a lower level in the audio section, tube and Johnson noise originating after it would have a 31 db handicap and with practical tubes and circuit constants, this effect would be insurmountable. The possibility of noise phase modulation in the first tube after V_4 is minimized by making this a frequency multiplier so that the noise deviations are multiplied by a smaller factor than those originating in V_4 and earlier.

Performance

The general performance of the Serrasoid system in the particular case shown, and following the design rules noted can be summarized as follows. The linearity of the phase-shift process is readily made to be equivalent to less than 0.1-percent f-m distortion for peak phase shifts of ±135 degrees. It should be noted that nonlinearity in the phase-shift process results in f-m distortion proportional to the order of the harmonic generated. Thus 1 percent third harmonic expressed as distortion of the phase shift is equivalent to 3-percent distortion measured as frequency modulation. In the commercial f-m broadcast modulator the distortion is largely controlled by the included audio amplifier, and the overall figure is held to less than 0.25 percent for 100-percent modulation at 50 cycles. At high frequencies where the peak phase shift is less the distortion falls until it is entirely accounted for in the audio circuits. At the upper end of the audio spectrum, distortion owing to tuned circuits in the frequency multipliers rises slightly, but by reasonable design is held below 0.25 percent, measured without de-emphasis. It is much easier to contrive that the distortion be this low than it is accurately to measure it once secured!

The f-m noise originating in the modulator and in the band from 50 to 15,000 cycles, measured with 75-microsecond de-emphasis is somewhat better than 80 db below 100-percent modulation. This noise is made up of approximately equal contributions from the crystal oscillator plate circuit and the plate circuit of V_{14}. It can be reduced still farther by designing for greater pulse bandwidth and higher tube currents, and by the special artifices described below. Microphonism is no practical problem at all with non-selected ordinary tubes. Because of the simplicity of the circuits involved shielding and isolation by ordinary means serves to suppress the noise effects of r-f feedback from high-level sections of the transmitter.

Increasing Phase Shift

There are two ways by which the total phase shift can be increased over the practical maximum of ±150 degrees. One of these is by cascading, or iterated modulation. The pulses at the plate of V_{13} are similar in form and amplitude to those at the plate of V_{24}. If, instead of coupling here to the grid of a multiplier, these pulses are fed to a duplicate of the circuit extending from V_{23} to V_{13} inclusive, another complete modulation process will have been encompassed. One stage of such cascading doubles the peak phase shift with the same percentage of f-m distortion and yet raises the f-m noise by less than 3 db. Thus the effective signal to noise ratio is improved by at least 3 db. The price paid for this iteration is two and a half additional tubes and a doubling of the audio power required to modulate. The process can be extended beyond two modulations. The other method involves generating two or more interlaced sawtooths at submultiples of the crystal frequency by means of a step-counter frequency divider; separately modulating pulses from each of the proportionately longer submultiple sawtooths; and recombining the sets of modulated pulses. The submultiple frequency, of course, must be more than twice as high as the highest modulating frequency involved.

In general, by the use of cascading and interlacing, as noted, by the use of a modification of the scheme employed in the Armstrong dual channel phase shift modulator, and by several other arrangements too detailed to describe here, the application of this system can be extended to cover a very wide field.

Commercial versions of the new modulator have been in use for the past six months at W2XMN-W2XEA, Alpine, New Jersey, and in the studio-transmitter link used to program KSBR, Mount Diablo, California.

BIRD'S-EYE VIEW—From a low-flying helicopter, here is how Electronics Park looks to a camera aimed due west and downward. All visitors are welcomed at the Reception Building (middle foreground), where they receive a marked map of the Park

The Editors Report on ELECTRONICS PARK

To build a combined headquarters, engineering heaven and de luxe manufacturing plant for its expanding electronics business, General Electric has invested heavily in a new plant at Syracuse. Here, along with the physical details, is the story of the people—the engineers, supervisors and workers—on whom hinges the future of Electronics Park

PART I—The Park and Its People

IN the rolling farmland near Syracuse, N. Y., has arisen an industrial phenomenon, a 155-acre campus combining research, engineering and production on a scale never before seen in the electronics business. This is Electronics Park, the headquarters of the Electronics Department of the General Electric Company. Nine buildings have been completed, stocked with machinery and equipment, and brought to operating status.

The Park is no idle experiment in bigness. When the war ended, GE had a greatly expanded electronics business located in 22 plants—with no headquarters plant. The company's long experience in the lamp business—and electronics closely parallels it in many respects—pointed the way to a headquarters plant for engineering, manufacturing, sales and marketing operations. And so Electronics Park may be said to be a modernized version of Nela Park. Both have the "campus" atmosphere, the last word in engineering facilities coupled with manufacturing operations and many satellite plants in various parts of the country.

Compared to competitors' plant facilities, the Park undoubtedly appears to be a "luxury" operation to many industry visitors. Contrasted to this attitude

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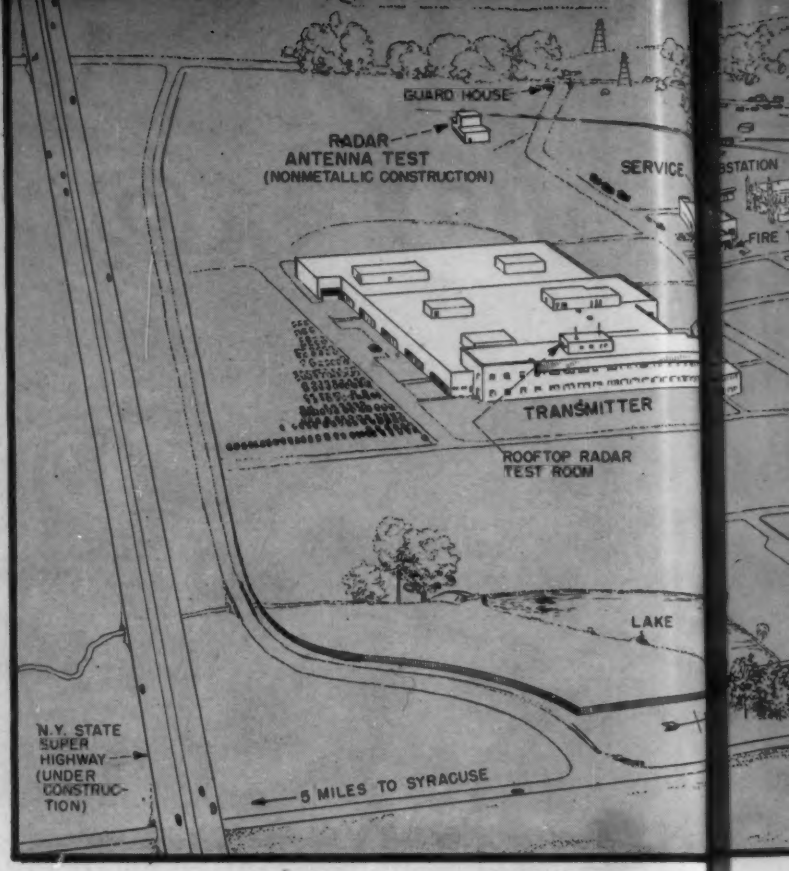
is the GE philosophy as expressed by Dr. W. R. G. Baker, vice-president in charge, who explains that management merely has provided the best possible postwar facilities and atmosphere for its engineers, office and production workers, and salesmen—all of which has already resulted in improved productivity as compared to similar GE electronics operations before the war.

The editors of ELECTRONICS undertook some months ago to study the operations at the Park. This report results from weeks of interviewing the engineers, the executives and the production workers. Its purpose is to describe features of the organization, its systems, techniques, facilities and methods. Some of these ingredients of creative productivity are, of course, equally applicable to many another plant or laboratory in the industry, and may well be adopted with profit by others.

The genesis of the Park goes well back into GE history. Since the early experiments of Langmuir, Alexanderson, Hull, Dushman, White, Coolidge and Whitney, electronic theory and practice had an important place in the GE picture. But electronics manufacture never loomed large in dollar volume compared with the company's apparatus business, for example. For years GE was completely out of the radio receiver business and practically all other phases of the electronics industry with the exception of building transmitters and receivers for the government and a comparatively small amount of industrial electronics equipment.

This was the result of arrangements approved by the government under the consent decree of 1932 whereby GE voluntarily liquidated practically all its previous activities in the field, most of which went to RCA—patents, products, machinery and engineers. GE went back into receiver production in 1937 at Bridgeport, Connecticut, squeezing into the household appliance plant. Since then, the various divisions of the Electronics Department have been living in other peoples' attics scattered over the eastern half of the country.

The vast expansion of electronic production brought to GE by the war further decentralized production. Even before the war's end, it was clear that the scattered electronic manufacturing plants could not be brought back to Schenectady, which was already overcrowded with nonelectronic activities. Planning for the Park began, in fact, as early as 1942.



THE PARK—155 acres of upper New York State farmland were converted into Electronics Park, headquarters of GE's Electronics

Why Syracuse Was Chosen

The first big decision was to find a site that would serve as headquarters and an engineering center for the Electronics Department, and have a large enough manufacturing plant to take care of practically all business in a normal year. The four major considerations in choosing a location were: (1) availability of labor to support contemplated production; (2) availability of air, rail and highway transportation, hotels and other community facilities; (3) reasonably central location with respect to sources of raw materials and markets for finished goods; (4) sufficient nearness to the research centers of GE to permit frequent contacts.

For the NEWS STORY with facts and figures, read

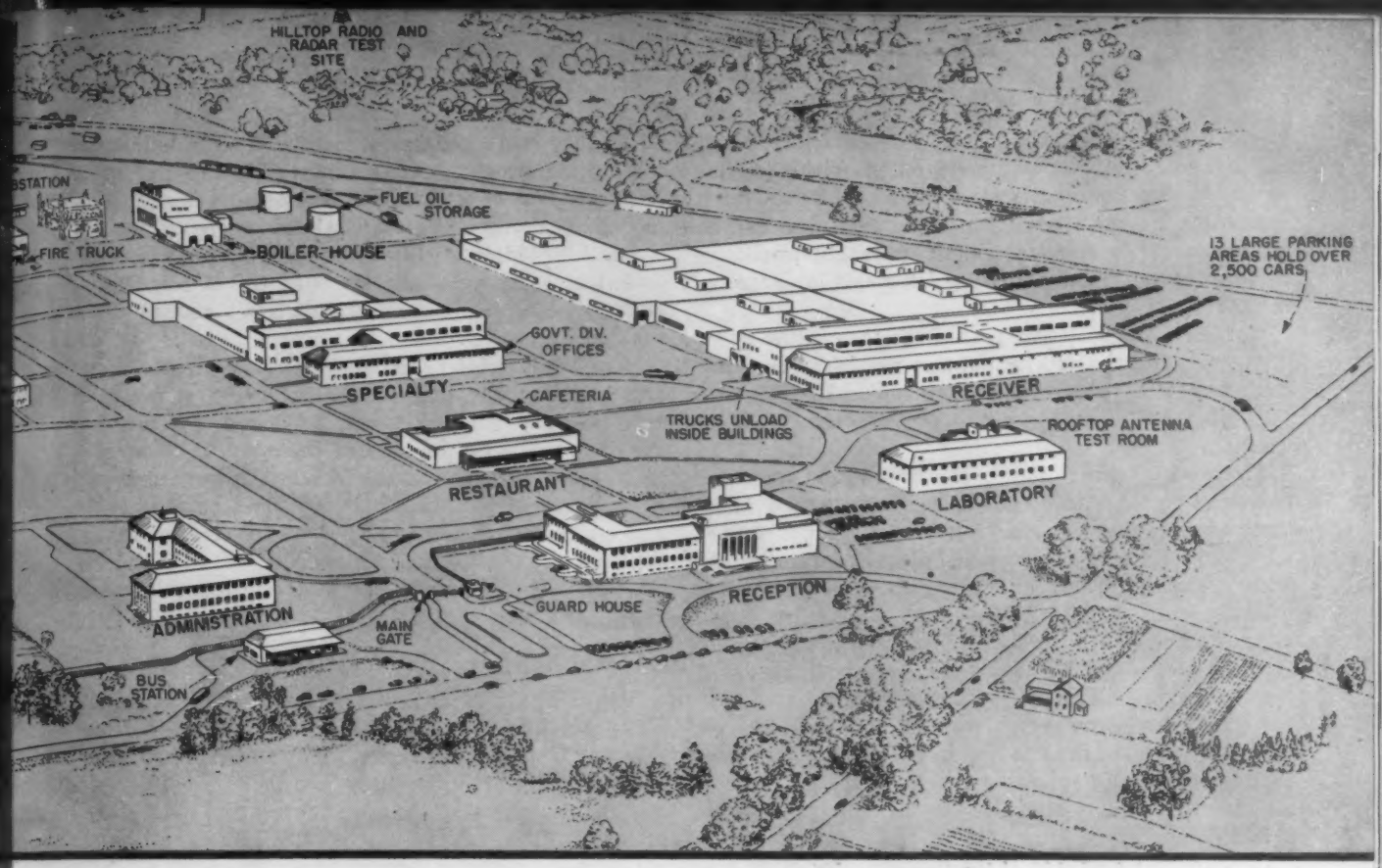
PART I—The PARK AND ITS PEOPLE ..... *pages 77-84*

For the picture of ENGINEERS at work, read

PART II—The ENGINEERING ORGANIZATION ..... *pages 85-94*

For PRODUCTION AND MANUFACTURING IDEAS, read

PART III—The PRODUCTION TECHNIQUE ..... *pages 95-100*



Department. Location is five miles northwest of heart of Syracuse and a half-mile from Liverpool. Of the nine buildings in the Park, one commands and five serve the three biggest, in which the actual manufacturing is done

Over a hundred communities were considered, some of which met all of the above requirements. Syracuse, however, had two plus values—a large group of employees that had operated the GE war plants at Thompson Road and Wolf Street, and convenient means for graduate study by engineers and other employees at Syracuse University. Therefore, Syracuse was chosen.

The 200,000 population of Syracuse is large enough and its industry sufficiently diversified so the Park's activities will not seriously affect the economy of the community. The city has a record of favorable union relations, and careful analysis shows that the Park can take a maximum of about 6,000 workers from the area without disrupting labor conditions in other Syracuse industries.

The site was picked next—155 acres of farmland about 5 miles northwest of the heart of town, on good roads and within the freight yard limits of Syracuse. Architects were engaged and commissioned to give GE a modern plant designed specifically for its electronics business.

Construction Problems

No job of this size could be undertaken without running into the usual labor difficulties. For example, the building design called for 1,800,000 bricks—presenting a tremendous job to get from the area enough bricklayers to finish the project. It was necessary, in fact, to obtain men from surrounding cities to handle the job.

Grading for Electronics Park was started in the fall of 1944, but the contractor worked only a few days before snow came. The ground was not seen again until the end of March, 1945. Construction started in September, 1945. In spite of difficulties of obtaining material as well as labor, the contractor started setting steel for the Transmitter Building in April, 1946. One year later this building was in operation, and production was humming. By early 1948 all main units were completed.

Units of the Park

The three largest units, the Receiver Building, Transmitter Building and Specialty Building, are combined engineering and sales offices and manufacturing plants devoted to their respective products. The remaining six buildings provide services and staff functions common to all activities. They include the Administration Building, Reception Building (which also includes an auditorium, the main hospital, employee relations offices, company store, classrooms, and a photo laboratory), the Laboratory Building, Service Building, Boiler House and Restaurant. Smaller units are available for special purposes, such as a hilltop test site for radar, and a nonmetallic building for testing radar antennas.

Construction of this plant required 500,000 blueprints, and over 100 engineers worked for a full year designing the layouts. Over 7,000 tons of steel were used in erecting the framework of the buildings and over 70,000 cubic yards of concrete were poured, much of it in bitter winter weather.

All offices and factory areas are air-conditioned. Fluorescent lighting and attractive tile floors are used in the offices and in all the factory buildings. The flooring in offices and labs is laid on concrete over a

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system of six-inch floor ducts. This permits obtaining a new power or telephone outlet within a few inches of a desired new location anywhere on the floor. Partitions are the Hauserman metal type that can be set up, moved or removed almost overnight to accommodate the continually shifting office and lab requirements.

There are 57,000 square feet of windows in the Park. Supplementing the natural lighting are 28,000 lighting fixtures of the fluorescent troffer type, with 100-watt units in the factory areas and 40-watt units in office areas.

The roofing, except for copper flashing on the office buildings for appearance, is of precast concrete slabs and standard built-up tar felt and slack. A tunnel approximately a mile and a half in length interconnects all buildings and carries domestic water, steam, a condensate return and telephone lines.

At seven points in the Park there are driven grounds tied together by a ¼-inch by 2-inch copper bus that runs through the tunnel system. Less than an ohm of resistance can be measured between any two of them. Each steel column in each building has its own copper conductor running to this ground system, as also do all water mains and all of the external shields for each shielded room.

The Boiler House has three 60,000 lb per hour oil-fired boilers which provide heating as well as process steam at an operating pressure of 75 lb. At present two 400,000-gallon fuel oil tanks are provided. Inasmuch as this huge project depends on a single 16-inch water line from Syracuse, a 1,200,000-gallon water reservoir will be installed to insure a continuous water supply for production needs and fire protection.

Power is received from the Central New York Power Corporation over two 115-kv lines. This voltage is reduced to 13.8 kv at a substation in the Park, for distribution to 35 unit substations located in penthouses on factory roofs and in basements of office buildings.

Within the Park there is a total of 3½ miles of track and interconnecting switches, arranged so that incoming material can be unloaded at the receiving dock in the desired building while other freight cars are being loaded at outgoing platforms. One GE 50-ton Diesel-electric locomotive handles traffic after receipt from the railroad.

Because the winters in this part of the country have low temperatures and occasional heavy snows, the service group has 3 V-plows, 2 Snogos that pick up and blow snow to the side of the road, a Jeep sidewalk plow, and several bulldozers. Adequate space surrounds each building and the roads so that snow will never have to be hauled away by trucks. Inside the Park are over 5½ miles of road, all paved with concrete and blacktop, plus about a mile of concrete walks going across the lawns.

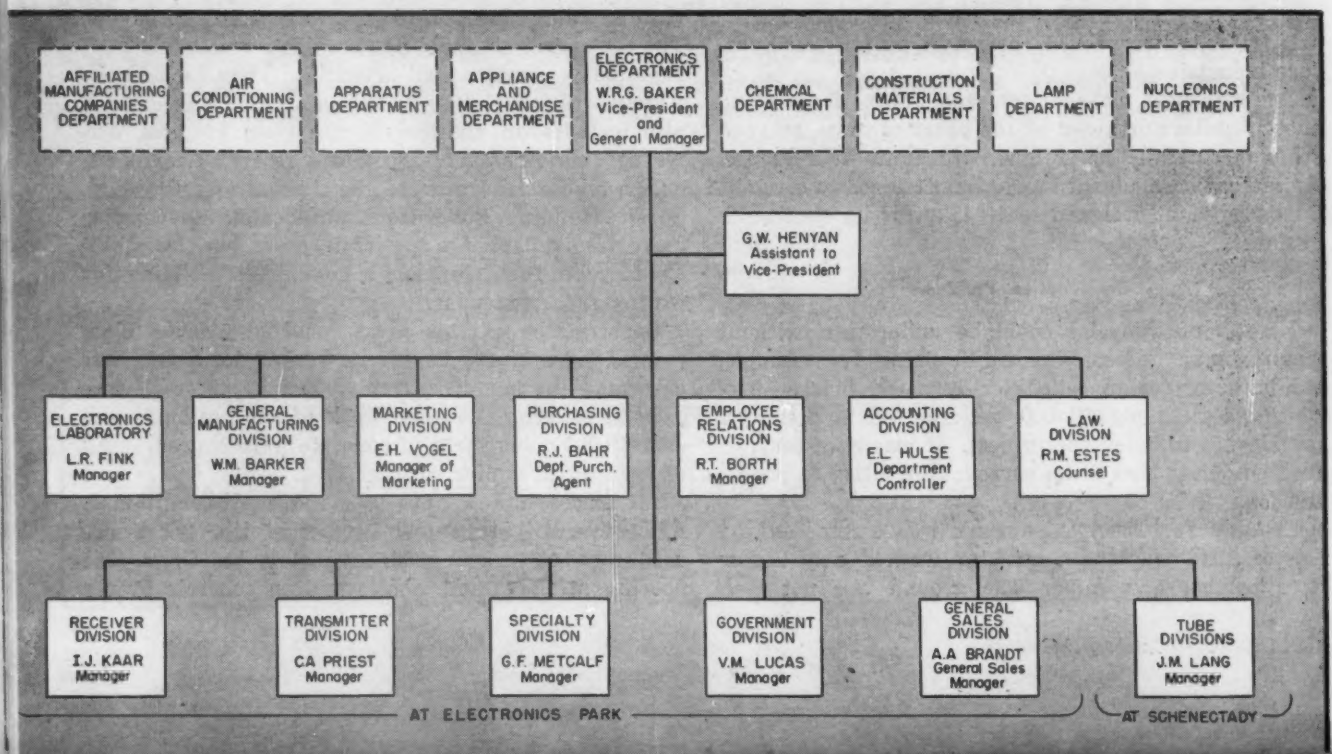
The Management Team

By mid-1948 the Park was erected, staffed and operating. The plant is there, a large investment that has to be managed along creative, productive and profitable lines of action. The Park, in Dr. Baker's opinion, is only incidentally buildings, equipment and machinery. Primarily the Park is people—the ideas they have, the work they do, the decisions they make.

In an outfit of this size, decisions are always potentially dangerous. For example, it takes over 20,000 radio receivers of any new model merely to sample the Receiver Division's dealers. So the right decisions on chassis design, cabinet styling, quantities the market will absorb, and pricing all are extremely important.

The big decisions are made by the management team shown in the organization chart. The Electronics Department is one of the nine operating departments comprising GE, shown at the top of the diagram. Each

DECENTRALIZED OPERATION—Organization chart showing relationship of Dr. Baker's Electronics Department to the other eight operating departments that constitute General Electric Company, with divisions under his wing shown in the lower rows



THEY RUN THE SHOW—Five engineers and a salesman, heading the world's largest concentration of electronic engineering and manufacturing facilities. Left to right: G. F. Metcalf of Specialty Division; A. A. Brandt, General Sales Manager; V. M. Lucas of Government Division; vice-president W. R. G. Baker; C. A. Priest of Transmitter Division; I. J. Kaar of Receiver Division. Not pictured is J. M. Lang of Tube Divisions, located in Schenectady rather than in the Park

Department is in effect a separate business, independent in its engineering, manufacturing and sales, headed by a general manager who in most instances is a vice-president of GE. The departments are assigned budgets at the beginning of the year by the head office, and are responsible only for returning the budget, with a profit at the end of the year.

The Electronics Department management is divided into two teams, the staff divisions (advisory) and the operating divisions. The staff functions, shown in the third row of the diagram, include services common to all operations, and are largely nontechnical. For example, E. H. Vogel, manager of marketing on the staff, represents the vice-president and advises the operating divisions on such matters as general departmental and divisional sales policies, product planning and pricing, merchandising plans and programs, advertising for all products, and market research.

Similarly, the other staff divisions advise the operating divisions on all important decisions, and are brought into operation as their particular services and experience are needed.

The technical staff unit is the Electronics Laboratory, whose function lies midway between the pure research work carried on in Schenectady and the operating laboratories concerned with development specifically for production. Its job is to develop ideas from the pure research stage to the advanced development stage, and it serves all the operating divisions.

The operating divisions at the bottom of the chart are, like the company's big departments, virtually independent businesses, working from a budget and returning it with a profit. Each division has its corps of engineers and production men, its own engineering labs and manufacturing plants, its own sales people. The heads of the divisions are thus primarily business men with broad management responsibilities. Like Dr. Baker, most of these men came up through the technical ranks of the company.

Operating Divisions

Largest of all the operating divisions is the Receiver Division, with close to 5,000 employees and about 1.5 million square feet of space. About half of these employees and 400,000 square feet of this floor space are in the Receiver Building in the Park, and the remainder is in satellite plants outside the park. This Division makes all kinds of radios and television sets en masse as its principal function and also supplies components, like loudspeakers, to other manufacturers.

Whereas many of its competitors procure the bulk of their engineering from the license laboratories to keep this expense at a minimum, the Receiver Division has preferred to stay in the engineering business and work to achieve the higher volume level required for the break-even point in order to absorb engineering costs. Since seasoned engineering organizations can-

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OUTPUT—Examples of many of the products made in the Park. In quantities ranging from one of a kind to hundreds of thousands, they fill freight cars and trailer trucks that leave the Park destined for distributors and customers throughout the nation. Products like large international broadcast transmitters and shortwave receivers are delivered to International G.E. Co. for export

not be created overnight, the existence of a receiver engineering organization is important insurance for the future. Furthermore, GE derives a great deal of prestige, as well as some material gain, through introduction of engineering advances even though these are available immediately to competitors through cross-license agreements.

The receiver engineer must often work toward two entirely opposite goals at the same time. On the one hand, he tries to design a set so there are one or more subassemblies that can be put together separately out in the open, where the work is much easier than deep inside a crowded chassis. On the other hand, a subassembly involves extra expense for producing the separate chassis and for combining it with the main chassis, hence the ultimate goal is to get rid of separate units. The head end of a television receiver is an excellent example of a legitimate and economical subassembly because it involves assembling a dozen sets of tuned circuits positioned around a selector switch, followed by alignment of each tuned circuit.

The Transmitter Division, whose chief function is to build big electronisms, comes next with about 2,500 employees, 90,000 square feet of floor space for offices and development laboratories, and a manufacturing floor equal to 210,000 square feet. The Transmitter Division divides its allegiance approximately equally between government and commercial customers. This was the first of the manufacturing buildings in the Park to go into production.

Although deadlines, economic factors, and the matter of eye appeal plague engineers in the Transmitter Building, commercialism is not nearly so evident as in receiver engineering. The work of the transmitter engineer is more diversified. There are about 192 graduate engineers in this division, of which 126 are in the engineering groups, 37 in factory inspection and test groups, and 29 in field engineering.

The Specialty Division, with some 500 employees and over 100,000 square feet of space, makes special electronic items. Measurement equipment for the new field of nucleonics is now one of the items receiving high priority. The Specialty Building is in the center of the Park.

Finally there is the Government Division, which utilizes about 50,000 square feet of space throughout the Transmitter and Specialty Buildings, and, in addition, about 200,000 square feet in the Thompson road plant in Syracuse. It has every possibility of expanding as government contracts are received for electronic equipments needed by our armed forces. Most of this business involves radar and other highly complex electronic equipment; in line with tradition, GE accepts many tough engineering jobs from government agencies.

At the beginning of World War I GE was doing government electronic business and has been in it ever since. The Government Division is strictly a quality business in every sense of the word, since the best is none too good for our armed forces. Govern-

THINGS AHEAD

IDEAS, some well along in development, that may become the products of tomorrow:

- Low cost, simplified television receivers
- Color television, electronically on a single picture tube
- Metal television picture tube
- Portable f-m receiver
- Radio remote control unit for appliances and for models
- Printed radio receiver, untouched by human hands
- Simplified superregenerative f-m receiver circuit
- High-frequency heater for thawing frozen foods in homes
- Microwave 60-second electronic range for restaurants and homes
- Electronic equipment for guiding and controlling missiles and rockets
- Pocket-size atomic radiation detectors with alarm
- All-electronic aerial superhighways for air navigation and traffic control
- Magnetic learn-to-read unit that pronounces words printed on keys which move pickup head to different parts of magnetized paper disc
- Advanced radar navigators for airplanes and ships
- Higher-powered television transmitters
- Super-powered broadcast transmitters
- Facsimile equipment for police, industry
- Personalized two-way radio sets

ment equipment is built to customer's specifications; there are no standard lines. The customer here always wants something new—rarely if ever is a product reordered, because by that time either the requirements have changed or there have been improvements in the design.

Government engineering occupies the entire second floor of the Specialty Building, with another wing downstairs for its executives. When a design is finished and ready for production, some of the engineers move over to the Transmitter Building with it to see that production snags get ironed out promptly.

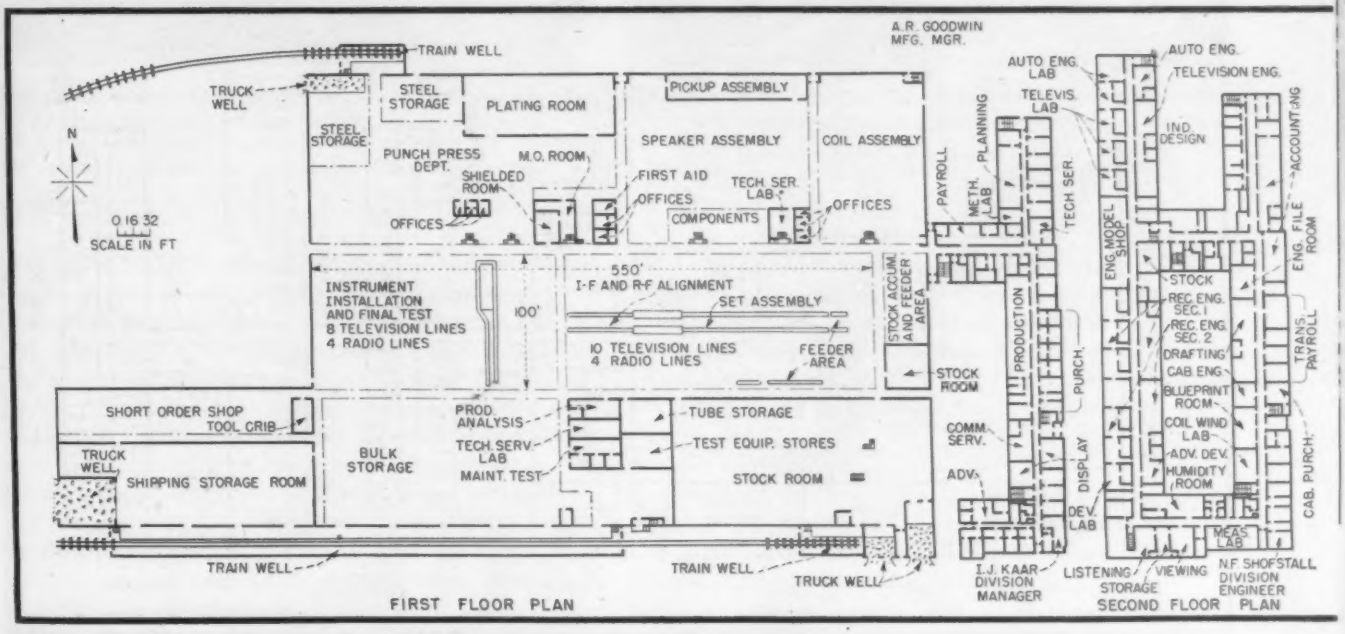
The General Sales Division management headquarters are in the Administration Building at the Park. It is responsible for the sale of the department's commercial products and for operation of the field sales organization in nine districts throughout the country, employing about 110 people. The manager of the division is also responsible for establishing adequate methods and channels of distribution, including distributor appointments and cancellations; for determining and administering commission plans for district managers and representatives; for the preparation of orders received and sales billed quotas for the districts and distributors; and for sales training programs for district representatives. He also shares with the product divisions the responsibility for product planning and pricing; merchandising plans and programs; production releases and scheduling.

Headquarters for the Tube Divisions of the Electronics Department are in Schenectady where one of the 5 tube factories of the divisions is also located. Original plans called for moving the divisions to the Park, in a separate building. The lack of labor available in Syracuse for all electronics manufacturing, and the cost of the move were heavy factors against it. Another factor was the close relationship between the industrial and power electronics tube work and the company's industrial machinery made or designed at Schenectady and sold through the Apparatus Department. These divisions make a large variety of industrial, transmitting, receiving and cathode-ray tubes in many satellite plants.

Plans for Expansion

The Electronics Department's policy is definitely to limit the Park operations to a payroll of roughly 6,000

RECEIVER BUILDING LAYOUT—Design engineers work upstairs, with production supervisors and the sales staff under them in the front of the building. All moving-conveyor assembly lines for radio and television receivers are in 55,000 sq ft center section



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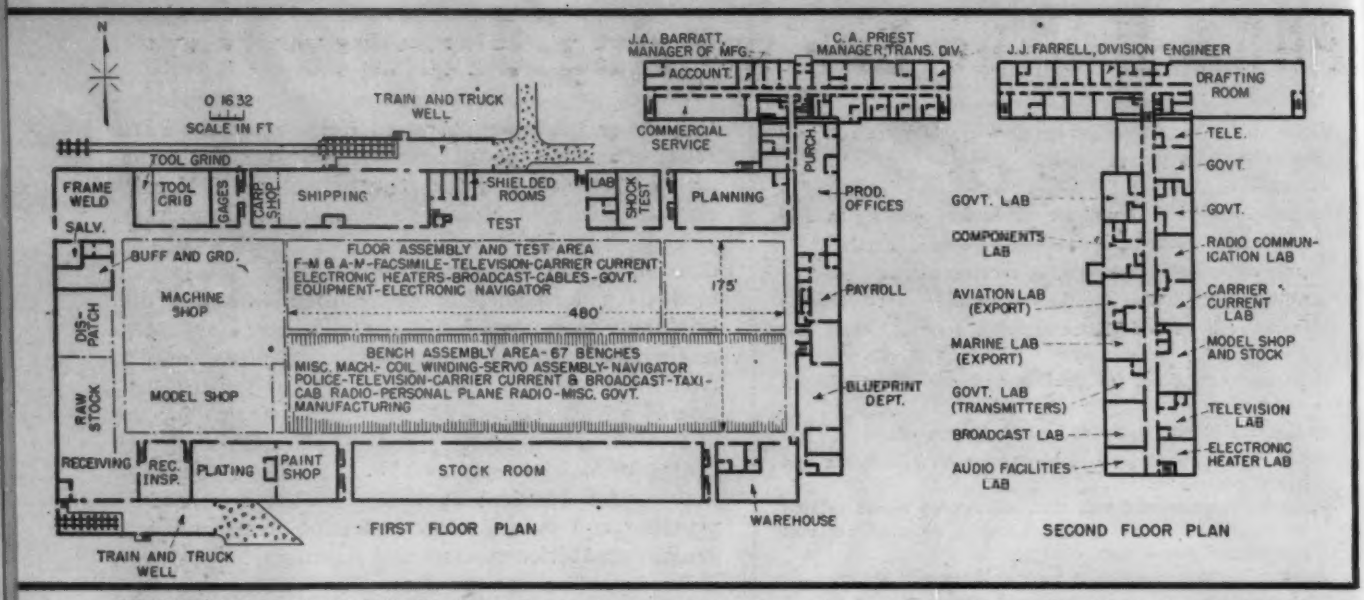


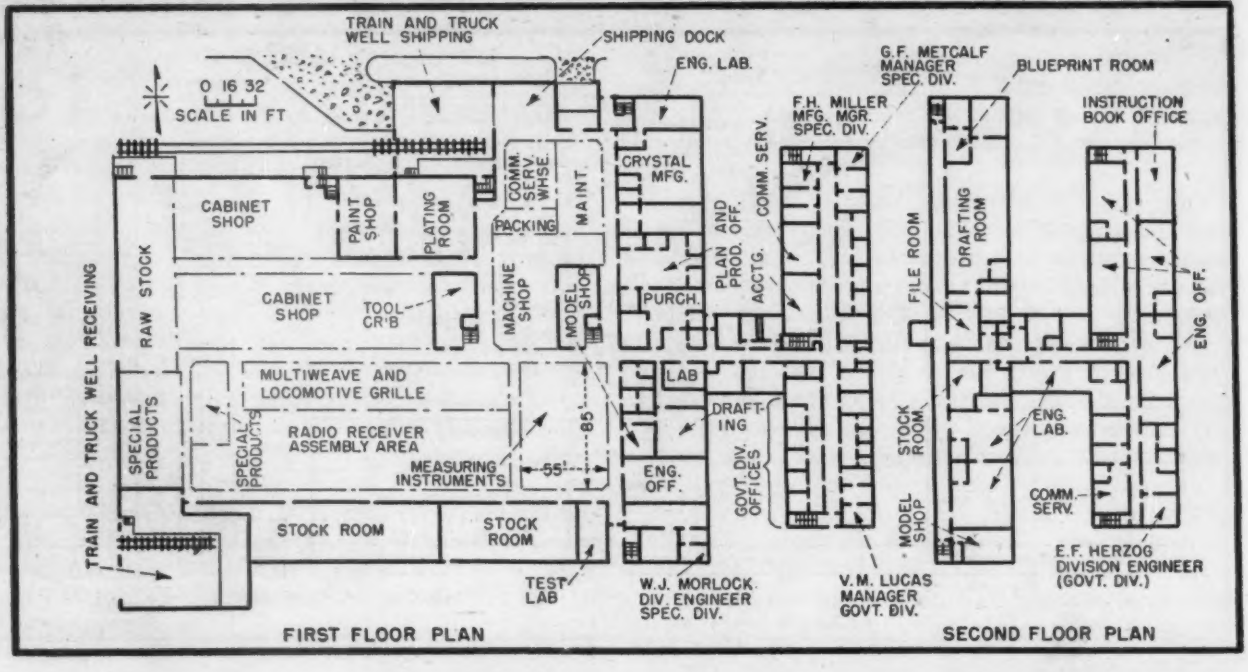
TRANSMITTER BUILDING LAYOUT—Engineers for the Transmitter Division are upstairs here, with supervisory and production planning offices over Transmitter under them in front of building. All assembly work is done either on the 67 benches or on the floor

employees, and to operate satellite plants for production beyond this point. For example, the Department has satellite plants in Buffalo, Clyde, Utica and Schenectady, N. Y., in Wabash, Indiana, in Owensboro, Ky., in Tell City and Huntingburg, Indiana, and in Irvington, N. J. These plants have, in all, 9,000 other employees and produce products like tubes, receivers and cabinets.

Expansion of the department's television receiver business this year has resulted in a plan to make all television receivers at the Park. By the year's end practically all radio receiver manufacture will be out of the Park in satellite plants and the entire Receiver Building manufacturing floor will be devoted to television. Since television receivers still need the attention of development engineers to keep things running, production in the Park will benefit from the close proximity of the television engineering and manufacturing groups.

The overall limitation placed on the Park's size by the availability of labor is an important advantage. The satellite plan of manufacture has an element of flexibility that would be missing in a larger concentration of facilities. Whenever more space is needed now, either temporarily or permanently, additional plants are acquired in cities having the required labor. Lines in heavy production, in which the engineering phases are essentially completed, get moved first to these outside plants.

SPECIALTY BUILDING LAYOUT—Specialty's engineers are downstairs, just off the manufacturing floor, because Government Division offices and labs occupy the entire second floor. The Specialty Division factory is essentially a big job shop



PART II—The Engineering Organization

TWO SIDES OF A WALL—When a Receiver Division engineer becomes suspicious of a loudspeaker, he can bring it to this lab and run off a complete response curve in a few minutes. The loudspeaker is mounted in an opening in a wall between the soundproof room and the measurement room, facing the microphone. A motor drive sweeps an audio signal generator gradually from 50 cycles to 20,000 cycles, while an inking pen traces on graph paper the amplified output of the microphone

ENGINEERING is one of the keystones of the structure of Electronics Park. The manpower devoted to engineering is a high proportion of the total working force. The manhours devoted to engineering, in development and production, are proportionately high, and engineering costs follow suit. Add to this the fact that in no other industry is the utility and cost of the end-products more closely tied to the technical skill of the men who design and make them.

It is not strange, therefore, that a major portion of the effort in planning the Park went into providing the best engineering facilities available. But facilities have to be operated, so the story of the engineering organization starts with the men. How are they recruited and trained, how assigned to jobs, inspired to top effort? What are their pet gripes? These questions answered, it is pertinent to inquire what they have to work with, and what problems they wrestle with. In that order, then, let us consider the engineering organization of Electronics Park.

Recruiting and Training Men

Except in unusual cases the newly graduated engineering student has never faced the basic engineering challenge: with data not known to be sufficient, and with a time schedule not known to be adequate, he must design equipment for some new application without losing sight of the basic requirements of cost,

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THEY RUN THE ENGINEERS—Reporting directly to division managers and responsible for the engineering of the Park's present and future products are these four division engineers and the manager of the Laboratory. Seated, left to right: J. J. Farrel of Transmitter; L. R. Fink of Electronics Laboratory; W. J. Morlock of Specialty. Standing: E. F. Herzog of Government; N. F. Shofstall of Receiver. Not shown is O. W. Pike of the Tube Divisions. Section engineers report directly to their division engineers

Only about half of those who complete the first year of this advanced engineering training will continue with it. The elimination is carried out in a spirit of mutual agreement; some have found the going too stiff, while others have taken up permanent jobs in a GE division where additional training of this nature is not essential.

ENGINEERS IN THE PARK

Design and Development Engineers	553
Engineers in Sales, Manufacturing, Etc	80
Total Engineers	633
Total Employees at Park	6,200

Types of Engineers

There are at least seven distinctly different categories in which the graduate of the Test Program or the engineering newcomer can end up: Research, advanced development, product design, manufacturing supervision, field engineering, sales engineering and commercial engineering. Each calls for its own particular combination of aptitudes, personality traits, and engineering knowledge. Furthermore, the duties of each vary greatly with the divisions—Transmitter, Specialty, Tube, Receiver, Government, Laboratory or Sales.

The chap whose interest is chiefly in the highly theoretical aspects of a problem, almost approaching those of a physicist, invariably ends up as a research engineer in the Laboratory. He has few cost responsibilities, seldom a delivery date to think of and delves only into the laws of nature.

The fellow who likes to work with his hands may end up as a product design engineer. In this category are most of the engineers in the Park. They take an idea and a blank piece of paper and produce working models and blueprints for production. They have to consider costs, eye appeal, delivery dates, and a multitude of related practical factors. A product design engineer, also known as a development engineer, is assigned to develop a particular product for which there is an order or a possible market, and he sticks to that job until a finished working sample is produced—or rather works on it whenever he gets a chance, because there is always a fire to be put out somewhere in connection with production of things he previously designed.

The organizing type of engineer is likely to end up as a manufacturing supervisor or section engineer because he likes to work with people. A factory train-

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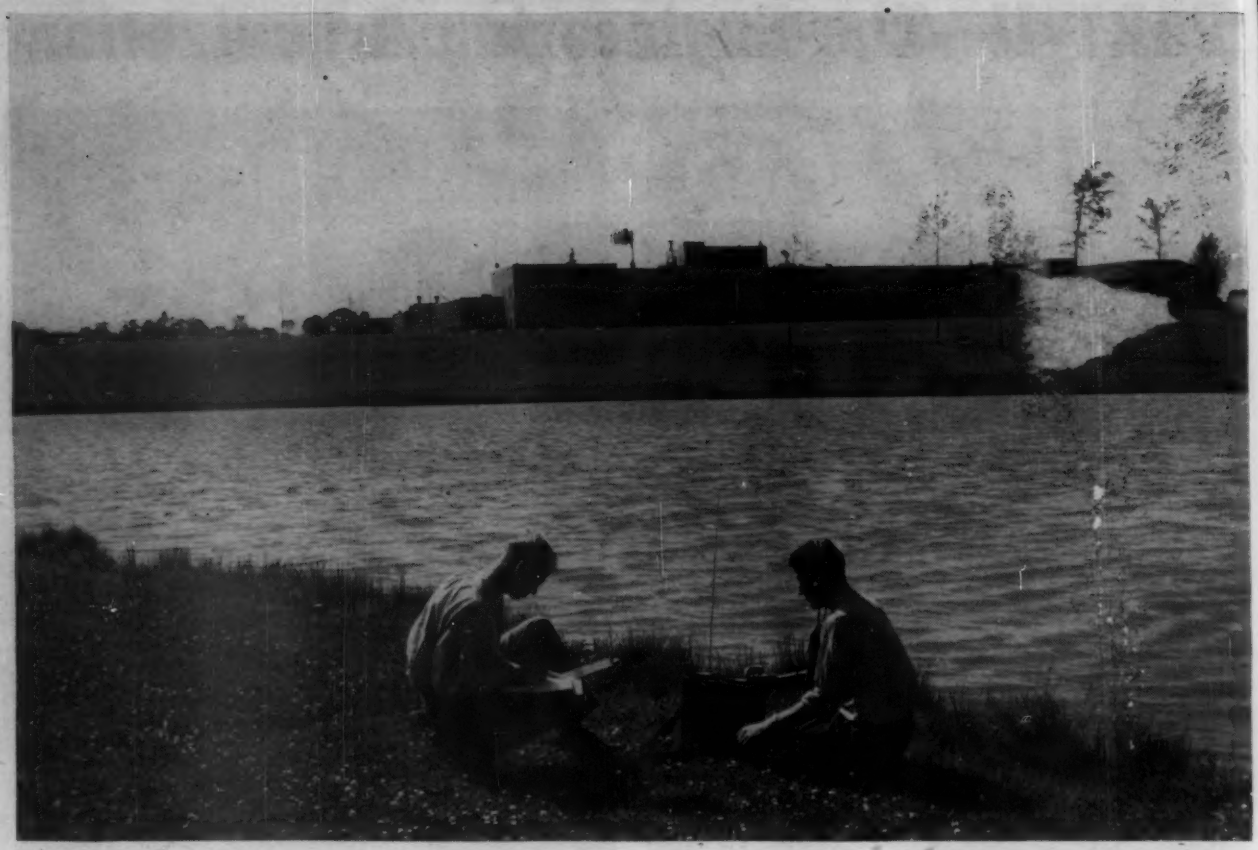


ENGINEERS IN CLOVER—Favorite site for field tests of communication equipment is lawn surrounding the lake in the Park, giving direct line-of-sight path to transmitting antenna atop Transmitter Building in background

efficiency, and dependability. GE has come to regard this aspect of an engineer's training as its own responsibility. Each year it absorbs into its laboratories, offices, and factories hundreds of young graduates from all parts of the country and from all types of colleges.

Channelizing such widely divergent backgrounds into occupations best suited for each calls for a flexible training program at all levels of aptitude and specialization. The best-known aspect of this is the Test Program. With few exceptions, most GE engineers select their specialized field via this medium.

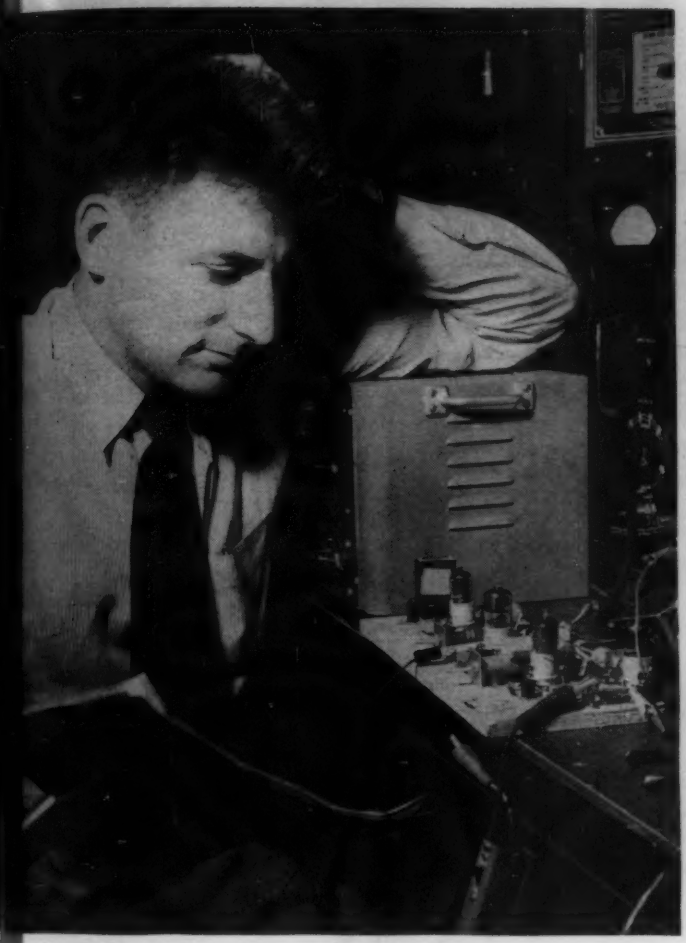
Finding a Niche

For a period of from one to two years each newly-graduated student engineer is assigned to many of the major departments. His responsibility is to test the products manufactured by those departments, and during the course of this work he observes the problems and methods that are peculiar to each activity. The average assignment period is three months. By the end of his test period he can select with some confidence the kind of work that offers greatest interest and opportunity to him. The majority of engineers at the Park are graduates of the Test Program. This system provides the Electronics Department with a continuing influx of young men with new ideas.

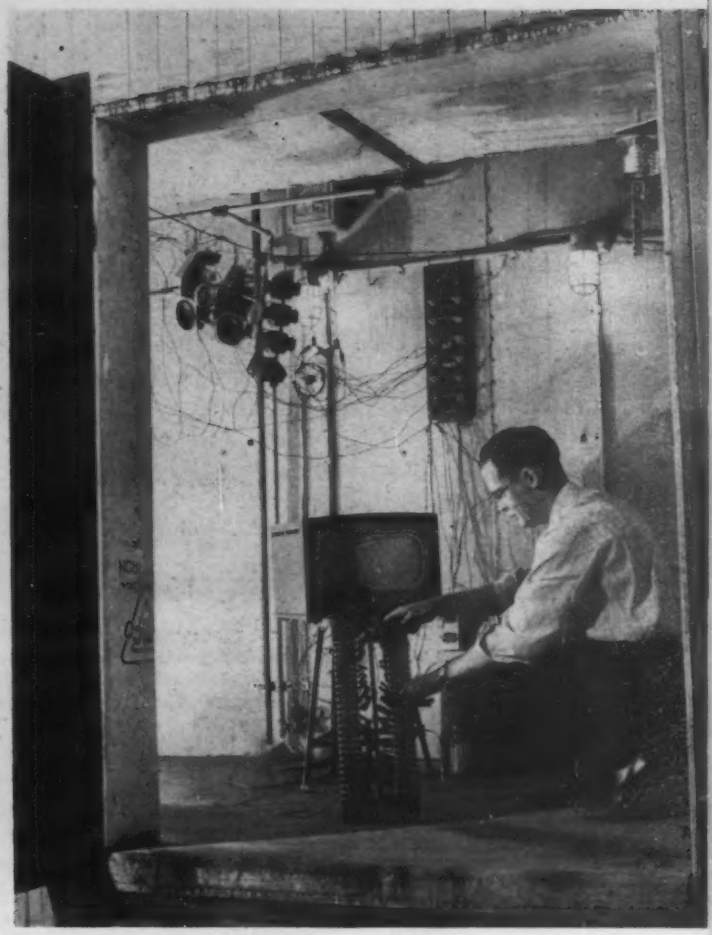
Electronics Park is, of course, one of the major steps for Test Program engineers. In addition, the Park has its own Test Program wherein graduates are transferred from building to building within the Park at approximately three-month intervals. This program is for those who have definitely chosen electronics as their life work.

Evening schedules of classes are provided at Syracuse University for engineers desiring to study toward their Master's and Doctor's degrees. These courses have been approved for benefits under the GI Bill. For other engineers, GE pays approximately two-thirds of their tuition if they complete their course satisfactorily. For those who do not, GE pays a third of the tuition. Courses are conducted at Electronics Park as well as in Syracuse University classrooms, and the thesis can be accomplished in any of the labs in the Park. At the present time, over 100 engineers at the Park are studying for advanced engineering degrees.

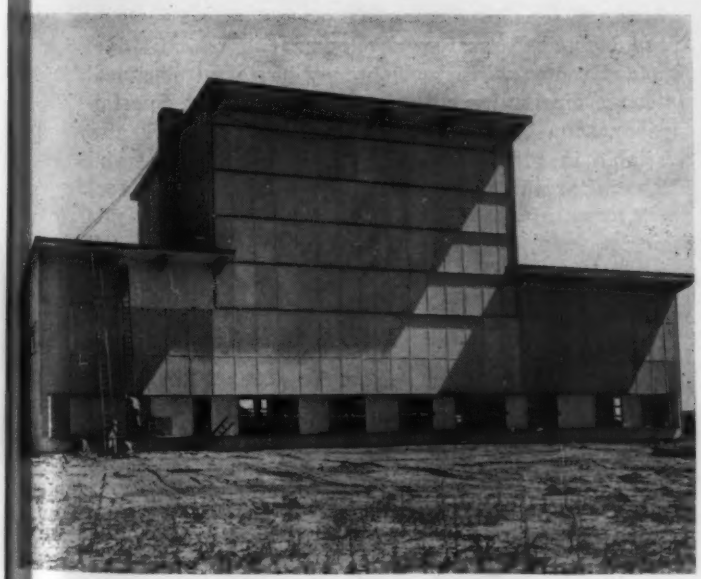
Another source for Electronics Department engineers is in Schenectady, where some thirty to fifty test engineers are selected throughout the company for an intensive course on engineering analytics. The course is a startling experience for every man who takes it. For four hours he is subject to intensive lectures by specialists called in from design sections or research laboratories. He is busy taking notes, for he knows that most of the material cannot be found in textbooks, and he likewise knows that the material might provide a clue to his weekly problem assignment—a clue which might reduce the 20 to 30 hours normally required for solution to 10 hours.



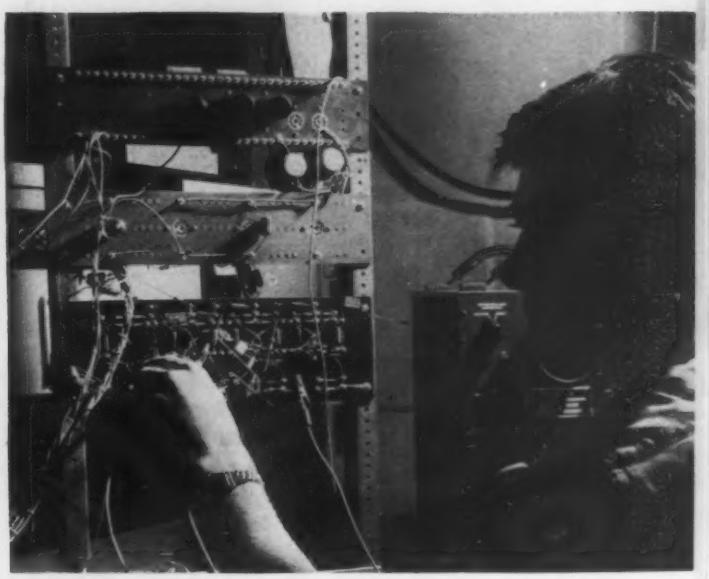
FAMILIAR BREADBOARD—A pause for meditation often pays during the breadboard stage of developing a new electronic product. Here is the true old fashioned breadboard, using woodscrews to hold the parts on the wood base



HOT BOX—Here receivers and components can be tested or operated for hours at temperatures up to 150 F and humidities up to 100 percent, to simulate ambient conditions encountered in any part of world where electronic equipment is used



ROOM FOR RADAR—Nonmetallic structure nearing completion at back of Park, for testing huge radar antenna arrays regardless of outdoor weather conditions. Even sprinkler system inside is removable for sensitive tests



REFINED BREADBOARD—A communication engineer in the Electronics Laboratory likes his breadboard circuits to be up in the air, accessible from both sides and supported by a relay rack. Other engineers fasten panels to small wood blocks

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WINDOWLESS HEAVEN—Shielded room inside one of the Receiver Division laboratories, with desk lamps for delicate tests when overhead fluorescents prove too noisy. All laboratories are air-conditioned, hence lack of windows here is no hardship

ing course is conducted for the express purpose of developing men interested in both engineering and production.

Combine an interest in people with good engineering know-how, plus a love for change and travel, and you have the making of a field engineer. Combine a liking of people with a dislike for the slide-rule engineering of his college days, and you have a sales engineer, simultaneously looked up to and down at by his fellow engineers. He can be as much as 75 percent engineer and still be a topnotch salesman because of the market nature of the product he sells.

Add diplomatic qualities and market analysis to an ability to look ahead and you have the commercial engineer, who provides liaison between engineering, sales and advertising and is broadly responsible for consumer acceptance of a product. He is a main source of ideas for new products because he is continually in touch with customers' needs. Part of his work involves writing the specifications he considers desirable for a new product, and later making sure that the final product is good enough to merit customer acceptance.

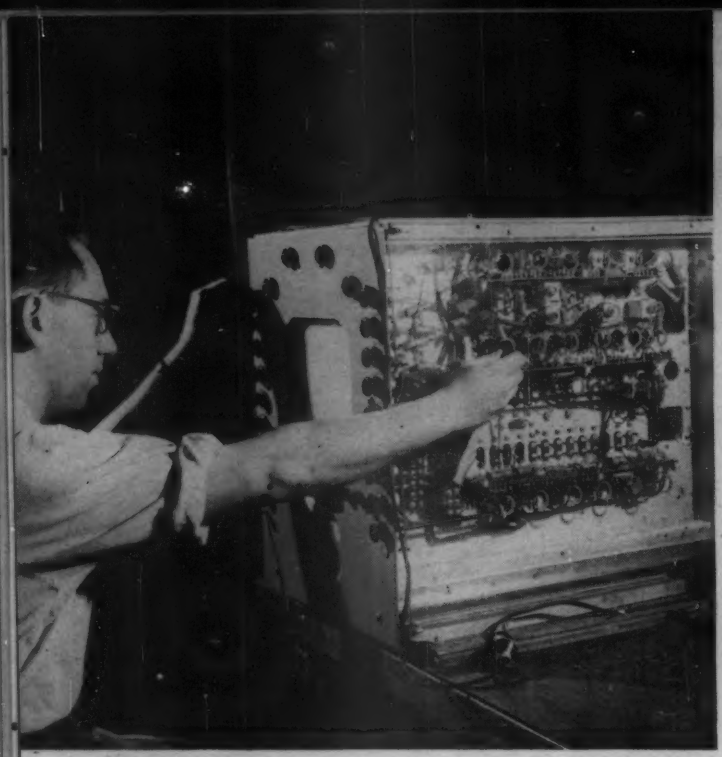
The engineer is encouraged and aided in obtaining professional recognition and prestige by membership and committee participation in engineering organizations, by delivering talks and papers before engineering and other groups, and by writing articles and books.

The secret of getting top-level engineering productivity lies in morale, particularly in the inspiration which can be passed to and from the engineer and his immediate supervisor. Throughout the engineering organization at the Park, there are generally no more than 12 engineers, and often as few as 5, under each supervisor. This makes for rapid two-way communication of ideas, discussion of gripes, and correction of difficulties.

Morale-Building Techniques

Each supervisor is aided in working with his group by reference to a nine-point job program developed from a company-wide survey of employees. If productivity lags, the fault can usually be found in the fact that the company has not considered one or more of the nine elements inherent in a good job: Compensation, working conditions, supervision, job security, respect for basic human dignity, promotion practice, information on management aims, belief in the individual job's importance, and satisfaction in a job well done. Inevitably, GE loses some engineers to other firms. Such moves are seldom discouraged by the management, and as a result GE can claim to have trained the best engineers of many a competitor.

Beyond the salary question, the gripes are scattered



MEASURING THROUGH LUCITE—Test program engineer checking television monitor unit by inserting prods through holes over dangerous high-voltage terminals. Transmitter test section has now been in operation over a year without an accident

HELP-YOURSELF STOCKROOM—For engineers who like to pick and choose, this Transmitter lab stockroom ranks tops in popularity. Cabinets have numbered drawers, and samples of parts are mounted on boards having corresponding drawer numbers

and to a large extent self-contradictory. One engineer goes so far as to measure with a recording thermometer the temperature of his air-conditioned office and to complain when it deviates beyond narrow limits, while another engineer objects that he cannot open the windows, sealed for the air-conditioning, to smell the clover on the Park grounds.

Regular meetings of all engineers in each division are held for discussions of any matter concerning the men and their relation to the company. Engineers interviewed say that these meetings are remarkable for their lack of double talk; an unpopular answer to a question is never evaded. Topics of discussion include salaries, employee benefits and services, the budget, profit and loss figures, plans for new products, and the competitive position of the Electronics Department with respect to the entire industry.

Engineering Facilities

The facilities for the engineering staff are of two types: an office and adjoining small laboratory where each engineer spends most of his working time, and specialized laboratories and a library.

The basic engineering office houses four to six men, and is approximately 12 by 23 feet in size. Adjoining it is a laboratory about 23 feet square, for the personal use of the men inhabiting the office. An elaborate system of conduits permits electric power of various voltages and frequencies to be brought out at each lab, as well as air under pressure, vacuum lines and specialized test signals, including video signals produced by the central video generator in the receiver plant.

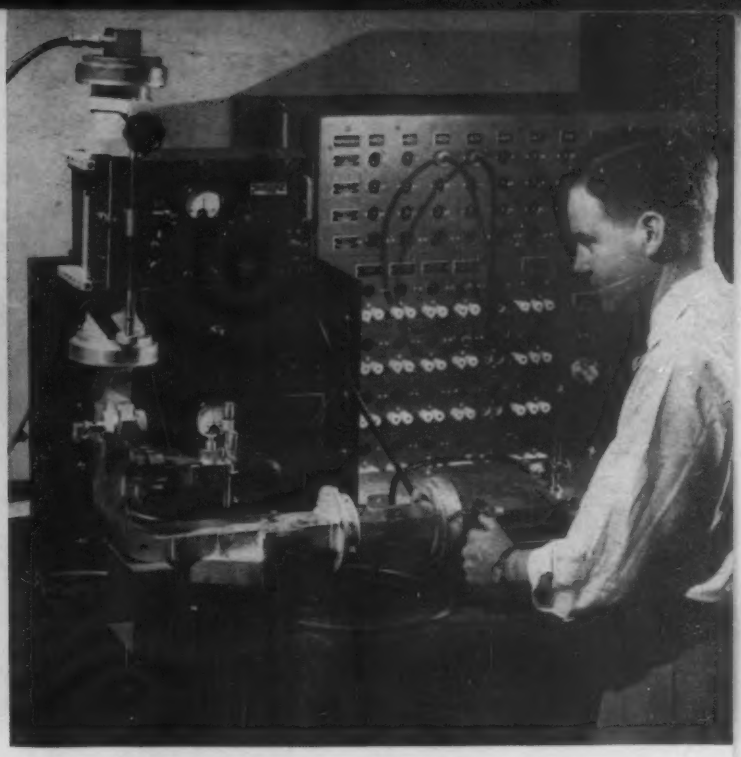
The equipment in each lab depends on the particular problem at hand. In receiver development, signal generators, vacuum-tube voltmeters, Q-meters, and oscilloscopes are to be found in nearly every lab, and more specialized equipment is available wherever needed. Each engineer is encouraged to requisition test equipment whenever and wherever it will fill a need.

Many of the specialized facilities are located in the Laboratory Building. These include the Park library, a model shop staffed with skilled mechanics and wiremen, a small chemical laboratory for testing materials, a plating laboratory, painting laboratory, welding laboratory, metallurgical laboratory and photographic darkrooms.

Most of the development laboratories, particularly those devoted to receiver development, have individual shielded rooms within which may be found electrical quiet, so elusive near manufacturing plants. Specialized antenna erecting and testing facilities are also available in profusion. On top of the Receiver and Transmitter Buildings' roofs are a number of 30-foot steel poles mounted on gear-and-crank mechanisms which permit a single man to raise or lower them. A special nonmetallic building 60 feet high, for testing radar antennas without interference from metal objects, is located in one corner of the Park. This contains a steel monorail crane support and a sprinkler system, but these may be temporarily removed. Radar and similar line-of-sight transmitters may be tested in the clear at a site on top of a nearby hill.

One objection many engineers have to working in a large organization is the tendency toward excessive standardization of equipment and methods. The Park management has attempted to avoid this pitfall, as witness the case of the lab benches. Five distinctly different styles of lab bench are in use, one for each of the four divisions and one for the laboratory. One design could have been imposed by the management,

SWITCHES TO ORDER—Instead of ordering specially made samples of complicated wafer switches and waiting weeks for shipment, engineers in one Receiver lab assemble their own at this cabinet, which contains all necessary parts



PLAYING WITH PLUMBING—Typical workbench scene in Government Division lab assigned to microwave development problems. Jumpers can be inserted in power panel at rear to feed any desired type of power to any particular bench

but the engineers couldn't get together on one design so Dr. Baker approved them all. Receiver benches are eight feet long, while Specialty benches are five feet long with drawers underneath at the right. The Receiver boys are quick to point out that the Specialty drawers are usually blocked by a soldering iron cord.

Six to twelve engineers share the same stenographer, an arrangement made possible by the fact that few of the engineers dictate correspondence and reports, preferring to write them out longhand for retyping. The stenographer is her own boss, an arrangement that avoids conflicting directions and leads to a display of tact on the part of the engineers.

Getting a Project Started

Ideas for new or improved products come from many sources. Perhaps the most valuable are those relayed from the consumer to the engineering staff via the commercial, field and sales engineering forces. Three noteworthy engineering developments of the Electronics Department, the self-contained antenna in standard radio sets, the variable-reluctance pickup and the high-brightness television picture tube, all started with suggestions from customers. Not infrequently the engineers themselves come up with an idea for a new product, but usually the engineer thinks in terms of improvements rather than innovations.

Whatever the source, the idea for a new or improved product is channelled initially to the commercial engineers and the sales department. This custom is a reflection of Dr. Baker's settled policy of developing only products that can be sold at a profit. The commercial and sales groups, aided by the staff's marketing manager, study the suggestion, calculate its ultimate selling price, then judge whether the market will take it at that price. If the answer is favorable, the idea achieves the status of an engineering project involving analysis, circuit design and breadboard-building to see whether the idea can be reduced to practice.

The projects thus approved go on a waiting list, from which they are removed in a priority rotation established by the division manager and his project committee. One of the divisions keeps track of available project engineers on a wall chart which shows the week-to-week progress of current work and thus gives some advance prediction of availability of engineers.

Often the work may be assigned to a project team, since it is not always possible to get the required combination of leadership, cost consciousness, engineering talent and originality in a single individual.

When the project engineer gets the project, with it goes a definite time schedule and cost budget. He is responsible to his supervisor for putting the project through within these established time and money limits, or else he must do a sales job to get more of each. The project engineer then requests other engineers to assist him in the work, and he's off to the races.

The first duty of a project engineer is to query the Laboratory in the Park to see if any new ideas are at hand or in the offing that can be applied to the job at hand. The Research Laboratory at Schenectady is also approached for this purpose, as is everyone else in the Park who may have thoughts or ideas to contribute. All this is routine, made compulsory to insure that the development team starts where others left off, rather than from scratch. Commercial engineers in that particular activity are asked what competitors are doing. Competitive products may even be purchased and dissected as a prelude to creative development work.

With all the facts at hand, actual design starts. Mak-

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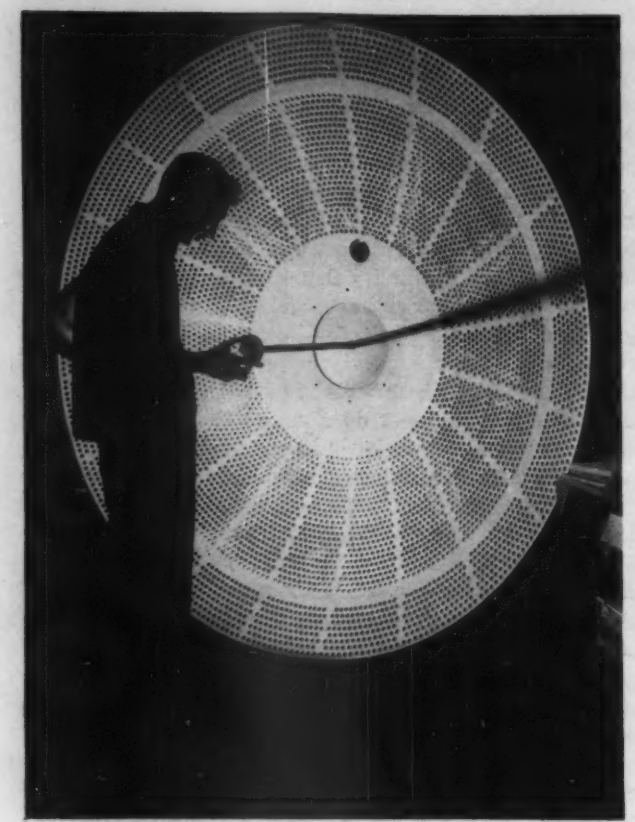
ROOFTOP PANORAMA—Radio communication test point on Transmitter Building roof, with land-line telephone "just in case"



FOR TELEVISION RELAYING—Parabolic reflector for microwave television relaying, ventilated to catch less wind. Engineer holds waveguide terminus that bounces signals back to reflector

ing it work comes first, and here each engineer has his own preferred type of breadboard. Some like to work on a flat metal panel supported by wood blocks. Some like their panels to be vertical, mounted on relay racks. Some simply let the parts flop around on the workbench for the early hook-ups, so changes can be made more readily. The higher the frequency, however, the more nearly must the breadboard version approach the final precisely machined layout.

Engineers having specialized knowledge and experience with components, cabinet design, mechanical design, theoretical principles and mathematical procedures are always available to help the engineer who is in charge of a project. In the component parts sections of the divisions are other specialists, thoroughly familiar with all parts available from other GE departments and from outside manufacturers.

Technical assistants perform the many routine time-consuming tests associated with development work. These are in no sense flunkies, however; each engineer is expected to clean up his own workbench, put away his own tools and instruments and run his own errands.

Sometimes the engineer builds in finished model-shop form the product that he designed. This is authorized on small rush jobs where there isn't time available to train others, or where the quantity needed is so small that it wouldn't pay to train others.

Transition to Production

As the project proceeds, there comes a time when the development engineer has to quit shelling corn, and

pass on whatever he's got to the next team in line. Separating the engineer from his brain child often requires real ingenuity on the part of the supervisor. No one can predict in advance how long it will take a particular engineer to develop an unknown new product to the stage where it is ready for production. Early estimates must be revised frequently as work progresses, and each revision makes the engineer less respectful of deadlines.

An engineer's goal is perfection. Knowing this, and knowing that perfection is never achieved, the wise supervisor works close enough with his men to know when the product is good enough, then takes it away by one means or another. It is rumored that one supervisor actually stole the finished sample while the engineer was out to lunch, and turned it over to production minus last-minute finishing touches.

The philosophy of the supervisor is to encourage his engineers to make and discover enough mistakes fast enough so that they can all be cleared up before production starts. Allowing an engineer to scratch his head carefully for an extra seven months during development is expensive, yet gives no insurance whatsoever against production troubles. Engineers are helped in this activity by an industrial design section which is primarily responsible for final appearance of the product, but also contributes to initial design innovations before the bugs are ironed out. Responsible to the manager of marketing, this section makes plastic pre-production models of portable radios and clay transmitter models, for instance. The hope and dream of the supervisor is that all early design bugs be little ones, such as are caused by tolerance clashes or mechanical misfits.

With electronic manufacturing back to its highly competitive pre-war status, quality of performance is no longer enough to insure sales. Overall appearance and styling must likewise be top-notch in the eyes of the customer, whether the product be a receiver, a transmitter, a tube tester, or even a tube. Today no design is permitted to leave a design section in the Park until it has been made up in model form from wood or plaster.

Even in the professional field of precision instruments, the engineer is faced with the problem of building a unit which will work and at the same time be commercially attractive. In time an engineer acquires this ability—a "must" to satisfy the commercial people and his designer's instinct.

Field Engineering Procedures

Whereas the Receiver Division sends out service manuals to take care of its troubles in the field, the Transmitter Division sends out a service man instead —an engineer who applies on the job those final touches that design engineers would like to do themselves. Field engineering achieves its greatest importance in the Transmitter Division, where each customer is fol-

EVOLUTION OF A RADIO RECEIVER

The development engineer here was asked to produce a table model set that would outperform competitive models. With a close deadline, the logical approach was to put in extra tubes and parts whenever in doubt. The resulting chassis, at extreme left, worked beautifully and was put into production, but manufacturing costs were out of this world because the chassis was flush level full of parts.

The engineer was kept on the job. One by one he removed bypass capacitors and isolation resistors, measuring effect on performance each time. At regular intervals a cost-reduction committee met to evaluate accumulated savings. By the time the engineer had half-emptied the chassis, the committee authorized launching of a new model (center chassis), and the assembly line was reprocessed for it.

Still costs were too high, so the project was continued. Soon the version at the right, stripped down almost to the bare chassis, will go into production

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lowed up and served directly by the factory personnel.

The field engineer by necessity has a degree in electrical engineering, plus at least a year in the test course. His job is to supervise the installation of GE transmitters and other equipment, as well as to take care of troubles that develop in the field. Thus, a high degree of tact and diplomacy is required.

Knowing the field engineer's aversion to red tape, GE requires reports only once a week. Longhand reports in pencil are okay, with no copies. When these reports come in, they are typed up and copies are routed to all interested persons. They may suggest design improvements and point out defects just as would a supercritical customer. The tough job at headquarters is to determine who or what is at fault—engineering, production, the tubes in the product, or the customer.

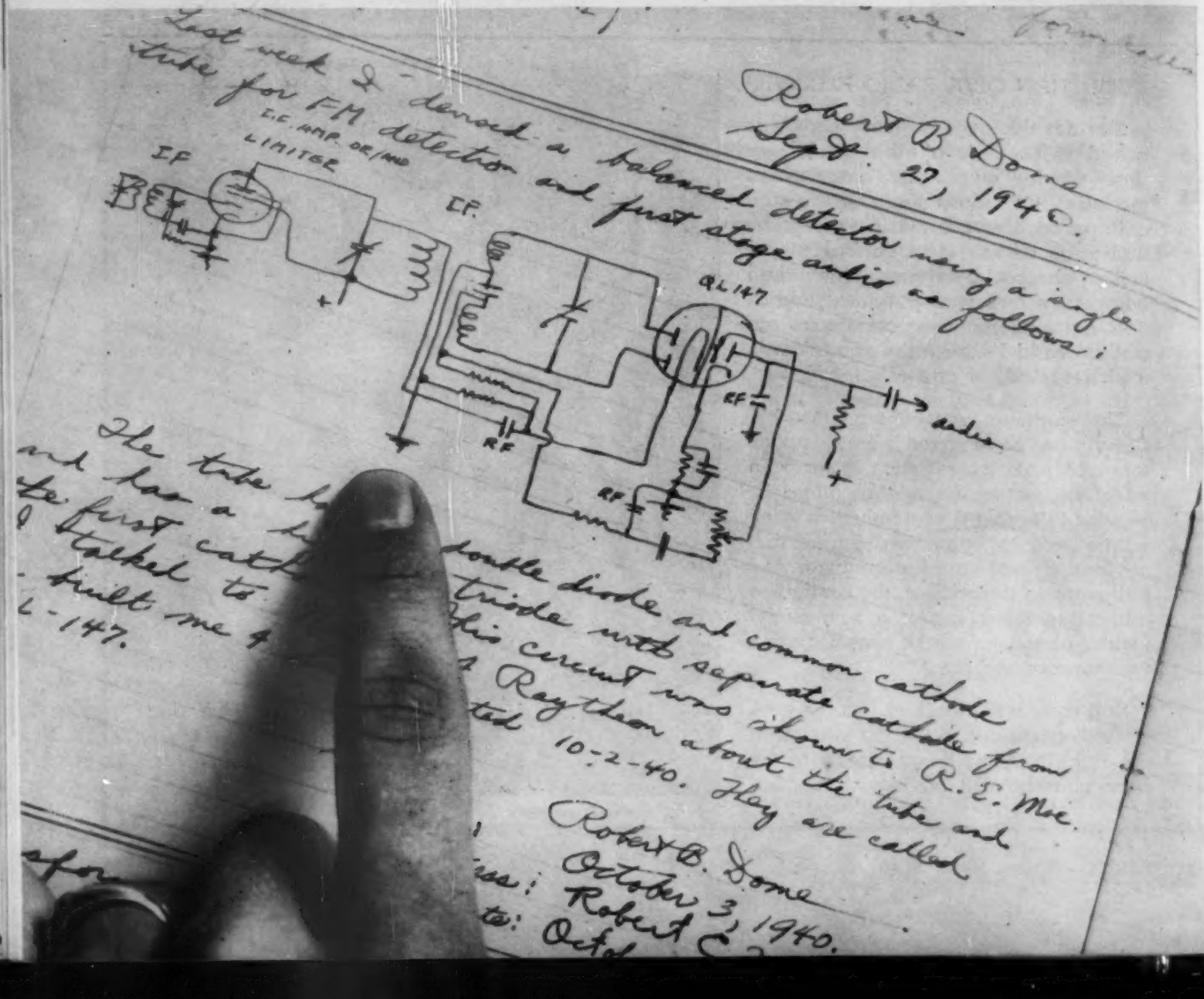
Responsibilities of the Laboratory

Between the fundamental work of the Research Laboratory at Schenectady and the applied development of the Division engineers lies the field of activity of the Electronics Laboratory. Here programs of advanced development or applied research are generated in all lines of the Department's activities, working about three years ahead of production.

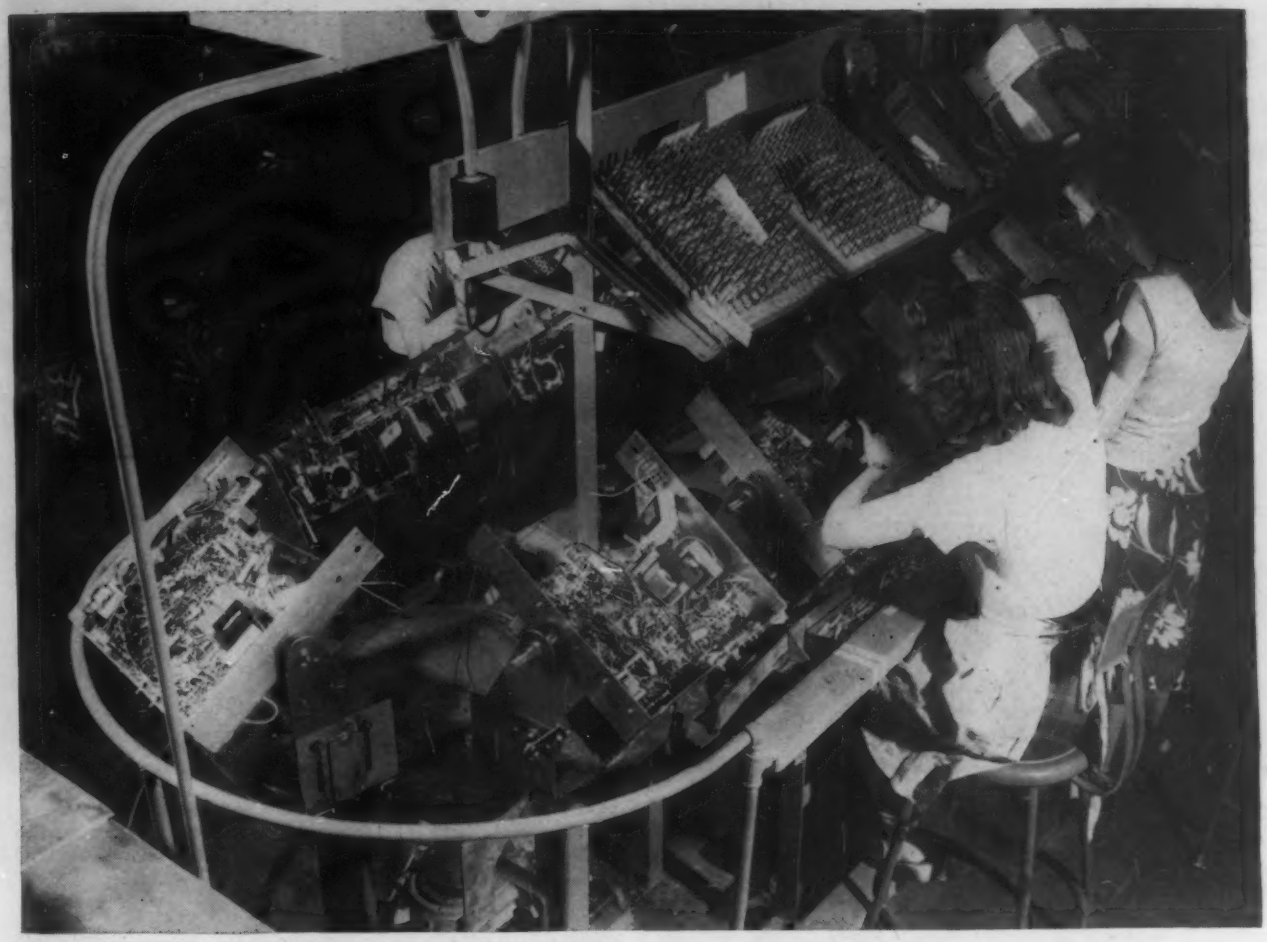
The Laboratory was started during the war years, and much of its effort is still concentrated on development programs for the military. It is growing at a rate determined by its ability to recruit and absorb men with the peculiar qualifications for advanced development. The present staff consists of approximately 80 people, of whom about 40 hold engineering degrees. The remainder are laboratory assistants, model shop mechanics, and the necessary clerical help. In addition, there is continuing rotation of from 6 to 12 assigned people from the company's training programs. While most of them move on to new three-month assignments elsewhere in the Department or in the company, all are candidates for replacement in the Laboratory.

The responsibility of development engineers in the Laboratory Building is to think first of the future and to take calculated risks in reducing research to practice as fast as possible, for the advancement of the electronic art and for the overall profit of the Department's operations. It is not expected that everything tried will work, nor is it expected that everything which works will get into production. All that is expected of the Laboratory is a continued output of ideas, ready for the next stage of development by the operating divisions.

PATENT LOG BOOK—Each engineer has one, in which circuits, ideas for new products, mathematical developments, and inventions are jotted down for possible use by patent department. Each patent application is good for a $25 bonus. Top man patentwise at the Park is Bob Dome, with 52 to his credit. Patent logs are examined regularly by men assigned to patent department liaison



PART III—The Production Technique



TELE COMING 'ROUND THE BEND—Chassis for 10-inch table model is two-thirds completed as it comes around this endless link-chain conveyor. Special jig on conveyor, fitting into holes punched in chassis for the purpose, permits setting chassis at various angles and turning it over whenever necessary as it moves down the line

FINAL production blueprints are converted into finished products in the Receiver, Transmitter and Specialty Buildings. The differences in manufacturing techniques in these three buildings are directly related to the type of product manufactured. A girl on a receiver line may do her assigned work in 30 seconds, whereas a girl at a bench in the Transmitter Building may work for days on the same unit.

In discussing production at the Park, certain definitions are necessary. *Production* means getting ready for manufacturing—doing everything except putting together the product. It is primarily moving of materials so they will be at the right places at the right time. The receiving room and the stock room are in charge of the Production Supervisor. *Manufacturing* is making things. Production starts long before manufacture and goes on concurrently with manufacture. *Inspection* is mechanical, involving checking of such things as dimensions, finishes and tolerances. *Test* is both electrical and mechanical, involving checking of electrical values or electrical performance characteristics of individual components and both physical and electrical specifications of the finished products. All four of these elements, integrated throughout all buildings, are the Park's manufacturing technique.

Broad decisions as to which division will make a particular product or line of products are made generally by the vice-president in consultation with the interested division managers and their staffs. Within each division, committees headed by the manager and containing members of commercial, sales and engineering sections meet weekly to determine the future of a product. One purpose of these meetings is to schedule future production so as to keep labor requirements as nearly uniform as possible and within the allocated labor quota for the division. One rigidly enforced rule is that every promise of delivery of a design or a production quota must be confirmed in writing if initially made verbally. Enough differences of opinion rise in the normal course of events without having arguments over who promised what.

Incentive Pay

In all Divisions, as many assembly workers as possible are employed on a basis whereby they can earn extra pay for extra output. During the period when

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MASS PRODUCTION—General view of manufacturing floor of Receiver Building, with television receiver assembly lines in foreground. By Christmas every line here will be making television's, and ordinary receiver production will be transferred to outlying satellite plants. Fluorescent lamps directly over each line and ceiling fluorescents provide 50 foot-candles at working level

they are training for a particular assembly operation, they receive a guaranteed hourly rate. Their earning climbs gradually as they acquire proficiency in doing their assigned work. On operations involving teamwork of many employees, group incentive pay is used.

CUTTING RECEIVER ASSEMBLY COSTS

Steady introduction of manufacturing shortcuts, like welding of resistor leads and ground straps to chassis, does not offset increased hourly rates for labor.

Automatic receiver-building machines based on printing and spraying techniques are under investigation, but the high initial investment required is a major problem.

Simplifying and cleaning up circuit design is therefore the most fruitful avenue of cost reduction.

Standardization on higher-rating components permits high-volume purchasing savings that often actually reduce cost. Thus, half-watt resistors are the smallest used in receivers, and 600-volt paper capacitors are standard except for cathode and avc circuits

Prices for incentive work are set either by time studies, by tables, or by comparison. All three methods take into consideration the native and acquired skill and knowledge of the employees, the amount of past training and education required, and the effort required in applying the skills on the job. The perfect system for measuring the relative amount of mental and physical effort required on various jobs has not yet been devised; perhaps it will never be, but the manufacturing staff is constantly working toward that end.

There is no attempt to lure labor from other manufacturers in Syracuse by offering higher wages. Records show scores of cases where workers left for higher wages only to come back a few weeks later to the clean working conditions, good lighting, air-conditioned comfort, and straightforward management at the Park.

Inspection of Parts

Inspectors in all divisions are on hourly pay to insure careful work, and many of them are engineering graduates. Inspection is based on modern techniques of statistical quality control sampling. As an example, if an incoming shipment contains 100 units the inspector will test 20 and pass all if there are no rejects. If there is one reject he tests 40 more, and passes the remainder if these 40 are all good. If he

finds more than one reject in the first 60, however, he either makes a 100-percent test or rejects the entire lot, depending on how badly the parts are needed.

Vendors who sell parts to the Park are rated every month on the quality of their product. Since the goal in the purchasing department is to have as many reliable vendors as possible on tap, for protection against shutdowns in any one vendor's plant, the purchasing staff will usually send representatives to the vendor's plant for a detailed look into the situation before black-balling.

Receiver Division Problems

The job of the Receiver Division is to manufacture radio and television receivers of uniformly high quality, according to schedules and at or below standard cost. After a receiver sample is delivered by Engineering, the Planning Section writes a detailed "process" (schedule of operations) and sets up the necessary physical facilities on the floor to care for the production of a given model. This process is based upon standard times and upon time studies made by the Wage Rate group. Concurrently Production takes over the vendors which have been established by the Purchasing group, schedules them and expedites material deliveries to meet the line schedules. As each given model progresses it is the responsibility of the Test and Inspection group to obtain, in conjunction with Planning, the necessary test and inspection facilities to care for the model adequately.

Before all the service divisions have completed their work, pre-production samples are built according to process insofar as possible and delivered to Engineering. Within two or three weeks thereafter a pilot run of 50 receivers is manufactured, using all the production facilities which will finally carry the processes, to check the equipment, allow training time for working leaders, and provide Test and Inspection Section with finished receivers for training purposes. This permits doing on a planned basis what is sometimes done on an unplanned basis at considerable extra cost.

After the pilot run, the line is manned. It becomes the responsibility of the Manufacturing Group to train new operators and to bring the line up to speed. Each line is provided with an organization chart showing the number of operators processed for the line, plus a line buildup schedule showing how many sets should be produced each hour during the period when the line is coming up to schedule. This training schedule is the result of considerable research; it is based on a formula which has been empirically derived to take into account such factors as the time-cycle, skill of workers, and rate of production desired.

Each line is divided into groups of ten to fourteen operators in charge of a working leader. These working leaders do the majority of training on the line. Absenteeism is cared for by training two or more girls to do the same job, enabling breaches in the line to be filled effectively.

Every attempt is made to allow nothing but quality

THEY RUN PRODUCTION—Managers of manufacturing, left to right: Harold Miller of Specialty, A. R. Goodwin of Receiver, and J. A. Barratt of Transmitter. W. B. Gillen, not shown, has corresponding Tube Divisions job at Schenectady. Meeting production schedules, keeping costs down, keeping quality up and keeping workers satisfied are just a few of their responsibilities

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IT WORKS—Adjusting horizontal and vertical linearity controls of new table-model television receiver, using video signal and 400-cycle tone obtained from central signal source through coaxial lines. Picture tube is inserted only for alignment and test here, as sets are shipped without the tube

WELDING REPLACES SOLDERING—With electronically controlled resistance welding, this operator is able to weld 15 grounding ribbons and one resistor lead to the chassis of a television set during the two-minute time cycle. A snap-action switch built into the welding electrode applies current automatically

products to leave the assembly line. This is done by check and repair and repeated inspection both in and after the line. Receivers which are in difficulty are analyzed as rapidly as possible and sent to the repair group for modification. The controlling factor in the speed of all lines is quality. A line must stay below 10 percent rejections, and speed is held down until that quality level is realized. It has been found, however, that running a line below half speed does not accomplish a great deal in the way of training; the training is principally for speed, and not simply for memorizing a relatively simple operation.

Inspection cannot in itself insure quality because there is still the possibility of human error in the inspectors and final test men. Therefore, sampling inspection techniques are employed in the shipping room, where sealed cartons are actually opened and sets are tested again. This final inspector has the authority to shut down the entire production line until the trouble has been corrected if he discovers defective sets ready for shipment. Of course, he must be pretty sure of his ground when he shuts down a line because this makes many people above him unhappy.

Getting a television line started, as many manufacturers have learned, is more involved than ordinary radio production. To obtain large-scale manufacture for example, one line at the Park was re-processed four times, resulting in many new work assignments and redistribution of operators' positions. The final setup, however, employing three moving conveyor lines in series was soon producing 400 sets a day.

Transmitter Division Production

In contrast to the Receiver Division which deals in mass production for orders frequently running to hundreds of thousands of units, the Transmitter Division rarely has an order for over a hundred units. Furthermore, some of these units sell to the customer for well over $500,000 each. The transmitter manufacturing organization employs about 2,000 workers and has approximately 20 workers under each supervisor.

The two main types of products are radar units, communication transmitters and special electronic items for Government use, and a wide variety of products for commercial use, including broadcast equipment (a-m, f-m, television), communication equipment such as taxicab, police, aircraft and marine sets, carrier current communication and controls, electronic navigators, electronic heaters, and facsimile equipment.

Most of the component items required in the Transmitter Building are specially designed and must be made or procured in small quantities. The production section has the responsibility of procuring all items called for on the material lists furnished by the Engineering Section.

On items to be manufactured in the shop, the Planning Section works out each individual step in producing the item and sets a price for producing the item. From this, the price allowed each employee per piece for each step is set and vouchers are made up for use by the employees as pay vouchers. At the same time, raw materials needed are accumulated in the stock room after careful incoming inspection test.

The foreman in charge of assembly of a unit now has on hand the needed raw material, the components purchased outside, and the pay vouchers covering manufacture of components and assembly work. He starts one or two people on the smallest assembly, gradually building up his group to the required size for the order on hand. Finished subassemblies are

ELECTRONICS DOES IT—Thyratron-tube control for drive motor of endless conveyor on television line (above head of man, with cover removed). Speed control knob is alongside. Crossover conveyor in foreground brings sets from end of first line (off picture at lower right) to start of second line

inspected and tested, and assembly of the complete unit is started. When finished, the Test Section proceeds to operate, adjust and test the unit in accordance with instructions issued by the Engineering Section. Most of the test work is done by Test Course engineers, working closely with supervisors. After satisfactory completion of tests, the manufacturing group gets a last chance for final mechanical inspection and touchup of the finish before the unit is shipped.

The test power house in the Transmitter Building provides a variety of voltages and frequencies, and these can be fed through a well-planned cable system to any test setup on the factory floor. Three temperature chambers are available for operating tests at extremes of cold, heat and humidity, as required for most government equipment and for some commercial equipment. Vibration and tilt tables that can duplicate the roll and pitch of a battleship, the vibration of an airplane engine, or the bouncing of a jeep over rough country are available for testing commercial as well as military equipments under simulated field operations. Shielded rooms permit measuring sensitivity and noise right on the factory floor. Dual lighting systems are provided in these rooms; fluorescent lights are normally used, but for delicate tests incandescent lamps can be turned on.

To insure maximum protection to the operator while conducting tests on live circuits, interlocked test cages, safety shields, a central grounding system, and many other safety devices are used. The success of these safety measures is indicated by the transmitter test section's record for 14 months of work—534,250 man-hours without a single lost-time accident among the employees.

Even the huge broadcast and shortwave transmitters are produced on an individual piecework basis computed according to the number of screws, wire, and parts each man installs. Workers with two distinct kinds of aptitude are used here. The true mechanic, who likes to mount things precisely and make them line up, is called an assembler and is used to do all of the mechanical assembly of a transmitter. The electrician type, on the other hand, likes to hook things up according to circuit diagrams; he is called a wire-

SCOREBOARDS FOR MISTAKES

Before each worker on every moving production line is a score card. Whenever an inspector or supervisor discovers a mistake, she goes right over to the worker responsible for that particular operation, and makes a mark on her score card. The psychology of this silent rebuke has been carefully analyzed; comparative tests made with and without the score cards show the system to be highly effective in keeping down rejects. A master scoreboard is kept for each line, in view of all workers, so they can see their hourly output and total rejections at a glance

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man and follows the assembler to complete the job.

The Specialty Division is essentially a big job shop, where the setup of a mechanical machine like a drill press or milling machine is changed as often as 20 times a day. It uses few mass-production techniques; just as soon as a product develops enough sales volume to become interesting to another operating division, it may be snatched away from Specialty. Here the men usually work from samples rather than detailed drawings.

The goal is to get the time cycle for a particular operation down to a minimum. In the Specialty Division this can be anywhere from 3 minutes to 40 hours, in contrast to the Receiver Division's average cycle of less than a minute. The number of workers assigned to a particular order depends on daily production requirements as well as on the size of the order. So flexible is production planning here that a rush job can be got out practically overnight if need be.

Small orders, up to the limit of 25 units, are produced in Specialty's model shop, just off the production floor, where everybody is paid on an hourly basis.

The secret of efficient production in Specialty's model shop is elimination of the paper work associated with planning of production and setting of piecework rates. An engineer develops a new product and turns it over to a wire man. He in turn wires up and builds a production sample, then teaches girls to make the rest of the run. All planning is done in the head of the wireman, with the girls memorizing their duties and using the production sample as their guide. With runs under 25, it costs more to break down the job on paper into individual assignments than the job is worth.

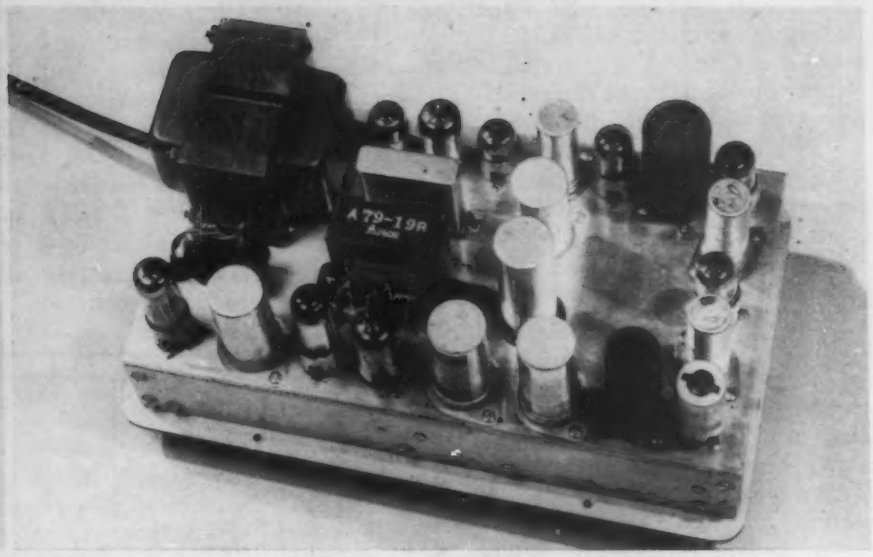
Conclusion

These, then, are the men and the facilities of Electronics Park. On them lies the responsibility and the challenge to substantiate Dr. Baker's theory that one can have the excellent accommodations of the Park and still meet competition. So far, the theory has stood the test of performance.

An article of this detailed nature, covering such intangibles as how engineers think, would have been impossible without the cooperation of a large number of people. A complete list of the names of those who contributed so freely of their time, their ideas and their data would fill this page, hence only a few can be mentioned. Appreciation is expressed to Dr. W. R. G. Baker for making this article possible; to E. L. Robinson for making preliminary arrangements; to Andy Tobin for scheduling the interviews and serving as guide during the entire period; to George Burns of Schenectady for photography; and to practically everyone in the organization chart of the Park for their help.—J. M.

ORGAN-TYPE CONSOLE—For small production runs in Transmitter Building, long time cycles are most economical. Here one operator does practically the entire job of assembling personal aircraft radios, working from a sample and eye-level instruction sheets

Controls and switches on panel



Chassis of electronic portion of the wide-range voltmeter for measuring narrow pulses

Peak-to-Peak Voltmeter

Pulses and transients of short duration are measured by an instrument having extremely high input impedance. Pulse-stretching circuits are used and an amplifier feedback arrangement provides substantially zero-impedance output

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IN THE DESIGN of electronic a-c voltmeters and ammeters, a desirable trend has been toward development of average or rms-reading instruments in order that the measurements may more accurately indicate actual power regardless of frequency or waveform.

There is also an increasing demand for instruments yielding peak or peak-to-peak indication of repetitive waveforms. This requirement is a more particular one in the instance where the average value over one cycle is negligibly small, as in the case of television synchronizing pulses, and in a wide variety of timing and controlling operations. Here, the energy level as represented by rms values may be unimportant, and the maximum (or minimum) excursion of the wave is the dimension to be measured together with wave shape and timing information.

In the design of electronic equipment such as high quality amplifiers, modulators, transmitters and recorders, it is the peak values of signal that extend beyond the linear range and cause undesirable transients, distortion and intermodulation. If the transients are of short duration, they are not measured by rms meters.

Measurement of the absolute indication of narrow voltage pulses imposes a rather difficult requirement on available materials and techniques. The voltmeter, to justify the term, must fully respond to the pulse without consuming it. The difficulty becomes immediately apparent when the usual diode peak-reading voltmeter is connected to a source of pulses of 2 microseconds width which are repeated say 10 times per second. Since the storage capacity in the diode circuit must be great enough to keep the output ripple small, the total energy continually dissipated by the diode load resistor must be supplied in less than 2 microseconds.

For example, if the peak 2-microsecond pulse voltage being measured is 10 volts, the energy in a 1-megohm diode load resistor will be 1×10^{-4} watt. This continuous power must be supplied in a small percentage of the time (0.002 percent). To supply this continuous diode load power, the source being measured must supply an instantaneous power of 5 watts. Since this

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is a rather high power level, neither the source being measured nor the diode of the voltmeter will handle it and the reading will be in error.

As the pulse width or the repetition rate is further diminished, the error is greater still. The effect is also more pronounced when the peak voltage being measured is below about 5 volts since then the curvature of the diode characteristic makes the diode impedance abnormally high and still further limits its peak power-handling capability. The combined effects described limit the best conventional diode peak voltmeter to measurements above a few volts and having a duty cycle not less than 0.1 percent.

The modern cathode-ray oscillograph yields both voltage and wave shape indications and with proper amplification and intensified trace formation, this instrument can identify practically any recurrent wave to the user when suitably calibrated. However, the combination of a stable electronic circuit and a precision meter will afford indications that can be made reliable within one or two percent whereas an accepted reading error of 5 percent accompanies the oscillograph indication. The latter figure may easily rise to 10 percent when the factors of calibration source error and its associated reading error are taken into account.

The basic design of the peak-reading voltmeter under consideration is the amplifier-rectifier type such as has been popular for a-c measurements in the past decade[1]. Each portion of the present instrument, however, demands a new approach to secure the desired response to steep wavefronts and narrow peaks.

Rectifier

The circuit employed to increase the rectified energy available for driving the output meter is illustrated in Fig. 1. The input wave encounters a typical diode rectifier in the first stage. Capacitor C_1 is, however, smaller and higher in impedance than is usual, permitting the grid of triode T_2 to rise to the peak value of a sharp spike without rounding it off. This diode and capacitor combination functions as a pulse stretcher, the output voltage being depicted in Fig. 1, along with the graphical representation of voltages in the other stages. The time scale shown is an approximate one but serves to indicate the effective increase in energy.

Since the impedance of the voltage source at the grid of T_2 is relatively high, T_2 is used as an impedance step-down repeater amplifier to drive a second conventional diode rectifier T_3 with the relatively long-duration (stretched) pulse to charge its output load capacitor C_2. Since the signal pulse has been appreciably lengthened, the duty cycle of diode T_3 has been improved considerably and no difficulty is had charging C_2 to the full peak value of the signal voltage. Triode T_4 repeats this d-c voltage into a low-impedance measuring meter.

Capacitor C_2, together with R_2,

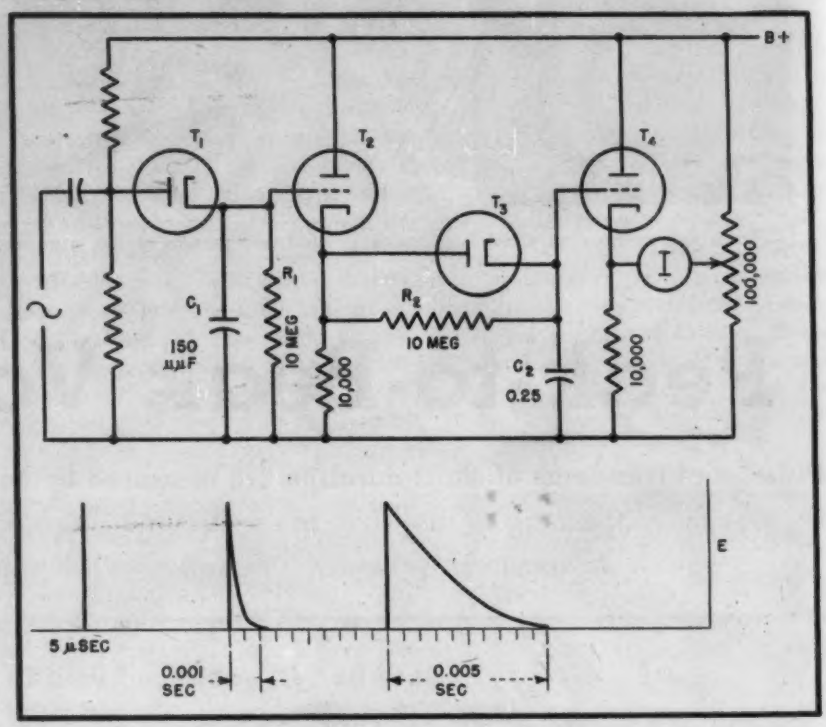

FIG. 1—Circuit and waveforms of pulse stretchers and impedance step-down repeaters

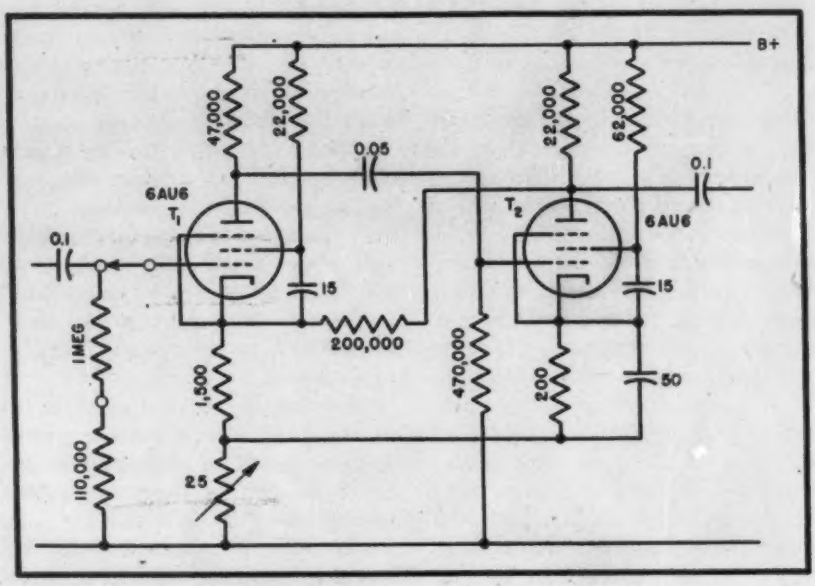

FIG. 2—In the preamplifier circuit, the use of feedback permits the amplifier to have substantially zero output impedance

determines the time constant of the meter circuit and at the same time, the low-frequency limit of operation. With the component values shown, this circuit responds uniformly to pulses of the same peak level when the pulse width varies from a maximum (square wave) to a minimum of less than 2 microseconds at 20 pps.

To adapt this rectifier circuit to the widest variety of applications, an amplifier preceding it is a necessity. The amplifier designed for this purpose provides wide input voltage range coverage with simple switching, uniformly high input impedance and low output impedance, adequate output voltage swing and high stability.

The amplifier is required to produce a linear output versus input relationship over a 10 to 1 amplitude range to satisfy the decade switching feature (the indicating meter is of the logarithmic scale type calibrated from 1 to 10). Furthermore, the low-voltage limit must exceed several volts to avoid encountering the curved portion of the diode characteristic. Finally, the stability must be such as to introduce negligible errors when factors of line voltage variation and tube changes are considered.

The present design yields a peak-to-peak voltage swing of 9 to 90 volts and the sensitivity of the meter circuit is adjusted so that these figures correspond to minimum and maximum scale deflection respectively. The incorporation of about 25 db negative voltage feedback insures amplifier stability equivalent to the attenuator and output indicating meter tolerances (± 1 percent).

Design of Amplifier

Initial experiments with the rectifier section showed that the signal voltage source impedance to the rectifier must be kept low if optimum peak response is to be had.

This factor demands the application of an amplifier ahead of the rectifier section even if only as an impedance transformer. It further requires the amplifier to have an output impedance of about 100 ohms if C_1 is to charge up to the peak value of a 1-μsec pulse in 0.01 μsec (or 1 percent of this pulse interval). The latter figures do not include the forward resistance of the diode or inductance of wiring and circuit elements.

The requirement of low driving impedance has been met by a method which has received relatively little attention. By its use, the apparent output impedance of the amplifier may be reduced to zero (or may be made negative if desired to compensate for positive resistance in the diode).

Figure 2 shows the basic amplifier circuit. Negative feedback from the plate of output tube T_2 to the cathode of the first amplifier stage T_1 causes output load variations to be reflected through the nominally high impedance of T_2 into the amplifier circuit. In this way, the cathode current at the output stage is effectively modulated by output load variations.

If the output load is low, the output current and cathode current of T_2 will be increased. The increased cathode current of T_2 results in an increased positive feedback voltage from the cathode of T_2 to the cathode of T_1. This acts to effectively increase the output current. The reverse of the above is true when the output load impedance is high. The proper amount of positive feedback as shown enables the amplifier to have substantially zero output impedance within the output current limits of T_2.

The principle employed in reducing the output impedance of the amplifier had been suggested some years ago[2,3] and had also seen practical application in loudspeaker amplifiers where excellent damping of cone resonances was observed[4]. A typical voltage versus frequency characteristic for a sine-wave input is shown in Fig. 3.

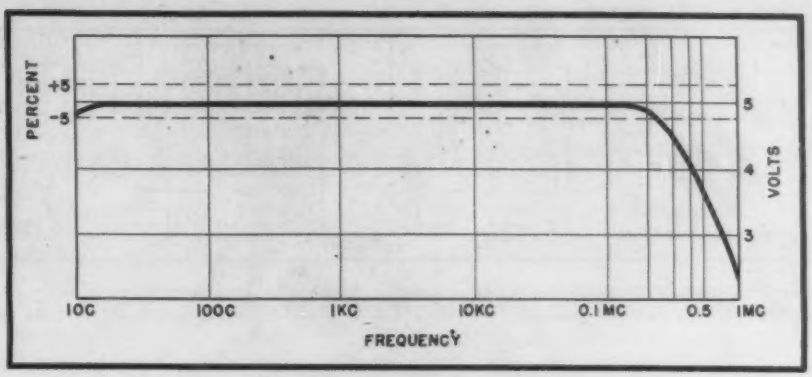

FIG. 3—Wide-band operation is indicated by voltage-versus-frequency characteristic

Second Amplifier

Additional gain is obtained by a two-stage preamplifier similar to that shown in Fig. 2 but omitting the positive feedback feature. The use of two separate, independent, cascaded amplifiers of two stages each permits use of an attenuator between the units.

The range switch includes a section which is interposed between the units and provides 10:1 step-down from maximum gain. By employing this arrangement as the first step of the attenuator, any slight noise or hum appearing in the input tube is thus reduced 20 db on all ranges but the first. The other ranges are accommodated by attenuation in the input to the amplifier. With the proper choice of compensated resistor elements, this has been found to be a most reliable method of range multiplication.

In the final version of the voltmeter, a full-wave meter rectifier circuit is used so that peak to peak values are indicated by the meter. This is believed to be of greater interest in the majority of cases than half-wave operation where polarity of only one sign would be registered. The instrument shown covers a range of 0.001 volt to 1,000 volts peak to peak or 0.00035 to 355 volts in terms of rms values of a sine wave.

References

(1) S. Ballantine, Electronic Voltmeter Using Feedback, ELECTRONICS, p 33, Sept. 1938.
(2) H. Bartels, *Elek. Nach. Tech.*, 9, p 319, Sept. 1934.
(3) G. S. Brayshaw, Regeneration in Linear Amplifiers, *Wireless Eng.* 14, p 597, Nov. 1937.
(4) H. F. Mayer, Control of Amplifier Internal Impedance, *Proc. I.R.E.*, 27, 1776, Mar. 1939.

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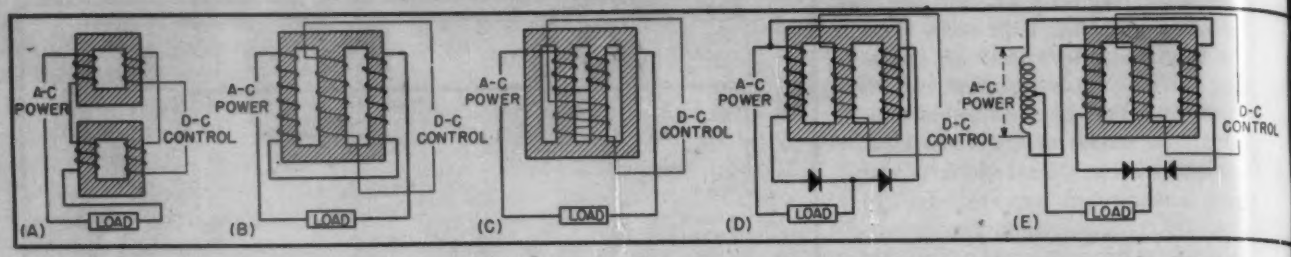

FIG. 1—Presaturated reactors can be variously arranged. The simplest form is two identical units (A), but equivalent results are obtained by winding the coils on one core (B) and (C). This configuration (B) can be combined with rectifiers to produce a doubler

Saturable Reactors

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BEFORE launching into a discussion of the subject, it is desirable to distinguish between saturable reactors and magnetic amplifiers. Without attempting to formulate definitions of these established terms it is, nevertheless, desirable to review some of the accepted differences recognized by workers in this field. It is impractical, even artificial, to distinguish between these devices on the basis of construction, function, or circuitry. To delineate the areas covered by the two terms on the basis of common usage is futile because they are used interchangeably, the older term, saturable reactor, being the more widely recognized.

A clear means of demarcation seems to be that every magnetic amplifier includes, as an essential component, a ferromagnetic device with adjustable inductance. Commonly, the amplifier is supplied with power from an alternating current source so that this ferromagnetic device can be a saturable reactor, or transductor as it is termed in Europe. From this viewpoint, a saturable reactor is a part of a magnetic amplifier. This viewpoint is not essential, but if followed consistently could avert ambiguity.

Saturable Reactors

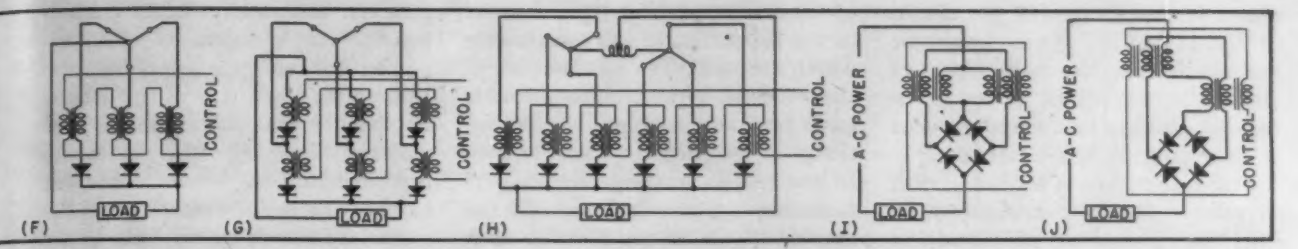
Several simple saturable reactor arrangements are shown in Fig. 1. The one in Fig. 1A can be made by connecting a pair of conventional two-winding transformers. The a-c or power windings may be connected in series or in parallel. The d-c or control windings are wound and connected with respect to the a-c windings that no net voltage of the fundamental power frequency appears across the control circuit terminals. The arrangements shown in Fig. 1B and 1C are quite similar in control characteristics to that at Fig. 1A. There are, however, slight differences involving transients and leakage reactances. Many variations of this basic circuit are possible, but all have similar performance characteristics. The manner of operation of the simple saturable reactor has been amply discussed in the literature and need not be reviewed nor enlarged upon here. The self-saturating type of reactor is of greater interest and, although it has been discussed in the literature, a brief explanation of Fig. 2 will show the essential features of its operation.

The circuit of Fig. 2A serves to demonstrate the operation of self saturation. While the circuit itself is of little practical value, it is the simplest self-saturating type of reactor circuit, and its oscillograms showing the effect of control premagnetization apply almost exactly to practical circuits. The circuit consists of a saturable reactor, a rectifier, a load and an a-c source all in series. The reactor has an auxiliary winding which is supplied with control current from a high-impedance source. The oscillograms in Fig. 2B show the load and supply voltages as functions of time and indicate the manner in which the load voltage can be adjusted by means of the control premagnetization. (The resemblance of this type of control to thyratron control is obvious.) Corresponding magnetic conditions in the core are shown in the lower oscillograms (Fig. 2C), which illustrate the effect of the control current on the minimum or initial flux density B_c, and also upon the undirectional pulsating load current. Adjustment over the range of control shown in the diagram (Fig. 2D) is effective in changing the output in a 100-ohm load from 1.5 milliamperes to 150 ma. It should be noted that the maximum flux density at the minimum current or cut-off condition (Fig. 2E) is so adjusted that the hysteresis loop is symmetrical and shows a total excursion of flux density of just less than twice the saturation flux density of the material.

There is a rather sharp increase of the load current as the core flux density reaches saturation. Because of this action the circuit yields to analysis on the basis of sharp firing. Such analyses have been made and give calculated waveforms and transfer curves that are in fair agreement with measurements.

As previously mentioned, the single reactor is of little practical value unless provision is made for minimizing the fundamental component of current induced into the control

This article, submitted June 20, 1948, is based on the paper presented by the author at the Symposium on magnetic materials sponsored by the Naval Ordnance Laboratory and held in Washington, D. C., June 15, 1948.



(D) or a full-wave circuit (E). These elements can be grouped (F), (G) and (H) for three-phase operation. Further elaboration of the single-phase circuits to obtain continuous rectified feedback current (I) and (J) results in the self-saturating magnetic amplifier

and Magnetic Amplifiers

Use of saturable reactors as components of magnetic amplifiers is described. The author discusses effects on performance of core material and assembly, and points out importance of reproducibility of core materials and rectifier properties. Applications are described

winding. This may be done by inserting a high impedance in the control circuit or by connecting two reactors or arranging several windings in such a way that the induced current is minimized. The last alternative is illustrated by the circuits of Fig. 1D and 1E. The circuit of Fig. 1D is called a doubler; it gives alternating-voltage output. The circuit of Fig. 1E is called a full-wave circuit; its output is d-c.

Effect of Core Material

The contrast between the sensitivity of the simple saturable reactor circuit and that of the self-saturating type may be seen in Fig. 3A. The transfer curves shown in this diagram were taken for two sets of reactors of approximately the same mean flux path, one constructed with standard E-I silicon steel laminations and the other with gapless medium-nickel iron alloy (Allegheny Ludlum 4750) ring laminations. In each case, data is shown for both the simple reactor circuit and the self-saturating type.

Two important differences are evident: (1) the increased sensitivity of the self-saturating circuit and (2) the improvement of performance obtainable with the better steel. With silicon steel, the self-saturating circuit is five times more sensitive than the simple reactor, while with the 4750 nickel steel gapless core, the self-saturating circuit for which data is shown is about 50 times more sensitive than the simpler circuit using the same core. Furthermore, in this same circuit, the 4750 iron has an advantage of 40 times in sensitivity over silicon iron. This makes evident the superiority of the better steel. Of course, the data are not strictly comparable because of the difference in geometry of the cores, but the curves shown may be taken as representative of conditions obtained in two types of cores which do have approximately the same mean magnetic path length. The peak ampere-turns of the load current is over 1,000 times the control ampere-turns for saturation for the self-saturating circuit with nickel-steel core, while the ratio in the case of the same circuit with the air-gap silicon steel core is approximately five for the particular set of data shown in Fig. 3A.

Similar contrasts of the sensitivity of the self-saturating circuit for other core materials, such as Permalloy, Permenorm 5000-Z and Supermalloy show increases in sensitivity over 4750 of the order of 2.5 times for the Permalloy and about 25 times for Permenorm.

The single-phase doubler and full-wave circuits may be arranged for polyphase operation. Several such circuits are shown in Fig. 1F, 1G, and 1H. The first (Fig. 1F) is a simple 3-phase Y-connection with the control windings arranged so that no voltage component of fundamental frequency appears at the control circuit terminals. Other circuits shown include (Fig. 1G) the 3-phase full-wave circuit and (Fig. 1H) the 6-phase circuit with interphase transformer. The polyphase circuits are commonly used for larger power outputs, particularly where fast response and optimum utilization of reactor structure are important. The latter condition develops in virtue of the fact that the several polyphase circuits have different internal impedances when made with identical reactors, permitting the load impedance, which may be fixed by external consideration, to be matched more closely.

Magnetic Amplifiers

Because the change in load current can be greater than the change in control current that produced it, saturable reactors can be used as amplifiers. To improve their performance, feedback is commonly used, particularly in the simple circuits that do not employ self-saturation. Usually the load current is rectified in a full-wave bridge and introduced in a special feedback winding on the reactor structure in such a manner as to aid the control current ampere-turns. Two single-

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phase feedback circuits are shown at Fig. 1I and 1J. As in the simple reactor circuits, the main windings may be connected in series or in parallel, and the load may be placed in either the a-c or d-c circuit.

Transfer curves of a reactor with adjustable feedback are shown in Fig. 3B. The effect of increasing the positive feedback factor is shown by the increased slope of the transfer characteristic. Of course, this increase in sensitivity with positive feedback is obtained at the expense of the speed of response of the reactor circuit and the stability of the system in which the reactor is used. Negative feedback results in an extended range of linearity of the transfer curve.

In both cases, window space is occupied by the feedback winding, so that the reactor structure must be derated by an amount which increases with the degree of feedback. As an example, in order to provide 100-percent feedback, (feedback turns equal to main turns), a simple reactor would have to be derated by 50 percent. For simple reactors without self-saturation, the use of feedback permits convenient adjustment of sensitivity in the range between that of the simple reactor and that of the self-saturating type and even beyond. The characteristics of the rectifiers are not critical.

The use of large amounts of positive feedback results in a trigger action that is apparent in the +2 curve of Fig. 3B. This trigger action can be exploited to advantage, as in the use of reactor circuits to give relay action which is quite sensitive and capable of high speed, shock-proof operation.

The performance of a magnetic amplifier system, particularly one of the self-saturating type, depends on the properties of the components which are used. The possibilities of the various circuit arrangements have been explored and the limitations on performance are known. In the self-saturating circuit, performance depends as much on the characteristics of the rectifier as it does on the properties of the magnetic core material. In discussing the performance of magnetic amplifier circuits, I shall mention the effect of both rectifier and core material characteristics and I shall attempt to do so upon two different levels: (1) what is now commercially feasible with normal manufacturing and quality-control techniques and (2) what seems to be the ultimate in performance of the best of present materials on a laboratory basis.

The principal performance characteristics of magnetic amplifiers include power gain, power output, speed of response, and weight per unit output. Other factors which may be of interest are shock resistance, ambient temperature limits, stability and linearity.

For optimum performance, the magnetic core material should have the following characteristics: (1) high saturation induction for low pounds per watt, (2) high differential permeability in the second and third quadrants of the hysteresis loop for maximum sensitivity, (3) high resistivity and ability to be made in thin laminations for low eddy-current shielding to give fast response, and (4) stability of magnetic characteristics under changing temperature and mechanical strain and shock conditions.

To be suitable for use in the commercial manufacture of reactors for magnetic amplifier circuits, the core material should have other characteristics in addition to those required for optimum performance. In the first place, it is of the utmost importance that the magnetic core material have properties which are reproducible between different batches and are the same for all the material in each batch. This is the single most important requirement for high-permeability core material for magnetic amplifiers.

Core Assembly

Considerable handling is involved in stacking laminations and in placing a winding upon the stacked core, therefore, it is desirable that the core materials be reasonably free from adverse effects resulting from moderate mechanical stresses. It does not seem feasible at present to consider the use of toroidally-shaped tape cores for low-level amplifiers (0.1 to 10 watts output) and there is no method presently available, to my knowledge at least, of obtaining satisfactory stacking factors with unit cores that are assembled before annealing and are used just as they come from the oven.

It is also necessary that the laminations have adequate interlamination resistance, which may be developed in stacks made of laminations with commercially available film coatings of the oxide type. Present practice consists of insulating the laminations before assembly with clear lacquer or impregnating the core after assembly with a wax.

The structure of magnetic amplifier cores has been a matter of discussion for some time. Performancewise, there are only minor differences between the core-type reactor arrangement, the three-legged reactor, and the four-legged reactor. For laminated, gapless cores, the simple arrangement using core-type reactors seems most practical. The limits on performance of circuits using reactors of this kind, particularly those made with high permeability core materials, are fairly well known, and the effects of core and copper geometry upon the various performance factors are understood in a general way. While the question of core and copper geometry for optimum performance remains an open one, rather definite conclusions may be eventually

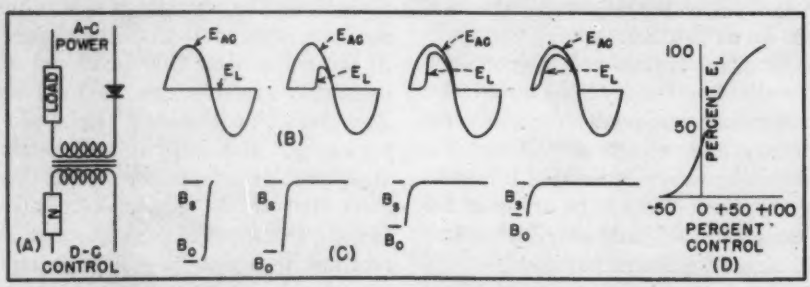


FIG. 2—Action of presaturation can be visualized from a reactor having control and power windings (A). Different values of control current produce different intervals during which voltage appears across load (B) because they shift operating position on the hysteresis curve (C) giving response shown at (D)

reached following a critical study of the problem. Early work along these lines indicates the feasibility of such a study.

Development work has been done on the basis of somewhat more limited objectives. A time constant of 1 cycle on a power supply period basis for the transient response of practical amplifiers is the present limit, while power gain, which is affected by the desired time constant, may be approximately one or two thousand if quick response is not desired. The watts per pound figure may be taken as approximately thirty for low-level 400-cycle reactor circuits. With rectifiers, mounting brackets and resistors included in an amplifier assembly, the watts per pound may become ten or fifteen for low-level, 400-cycle units. If these three factors are the only ones of importance, that is if cost and space are not involved, it seems quite feasible to reach rather definite conclusions concerning optimum core geometry. If, on the other hand, space is also important and high gain may be sacrificed, the rectifiers would be of different design, as would the optimum core shape.

Reproducible Core Material

The importance of the reproducibility of magnetic characteristics of the core material for magnetic amplifiers is shown by Fig. 3C. This graph shows measured magnetization curves of several samples of high permeability core materials, all of approximately eighty-percent nickel. The solid lines represent the catalog information given by the manufacturer as the average and extremes of the normal magnetization curve. The dashed-line curves show several measured curves for cyclic magnetization and indicate that the extremes given by manufacturer are not at all pessimistic. A range of maximum reversible permeability of 85,000 to 25,000 it seen to exist in the measured curves, which were taken for representative samples. A range of maximum normal permeability of 300,000 to 60,000, or 5:1, is shown in the data.

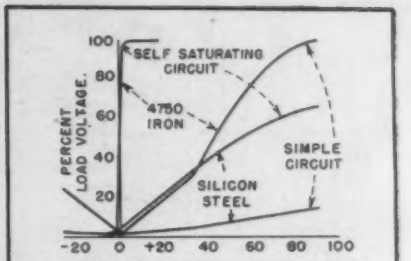
The sensitivity of a magnetic amplifier circuit using reactors made with Hymu 80 or Mumetal, materials similar to that of Fig. 3C, depends on the slope of the upper branch of the hysteresis loop, particularly in the region of zero magnetic flux density and the coercive force value of magnetic intensity. The slope of this portion of the hysteresis loop is dependent to a large extent upon the maximum value of the normal permeability. Changes of normal permeability in the ratio of 5 to 1 result in changes of magnetic amplifier sensitivity of approximately the same ratio. This condition is intolerable from the standpoint of large-scale manufacture of magnetic amplifier systems with fixed or published characteristics. Variations of this kind and magnitude are not amenable of compensation by other than laboratory methods which are often too costly for this type of product.

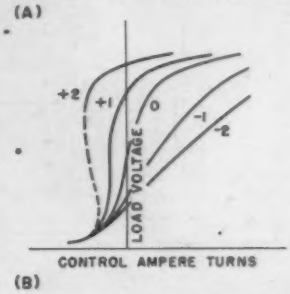
I think it safe to state that those who are interested in the manufacture of magnetic amplifier components and systems would be gratified if means were found to manufacture a core material with characteristics reproducible to plus or minus ten or even twenty percent, even if this were done at the expense of radically reduced values of maximum permeability and increased cost. As a matter of fact, I feel that this would be a more valuable contribution to the art than the development of core materials of even greater permeability than those presently available.

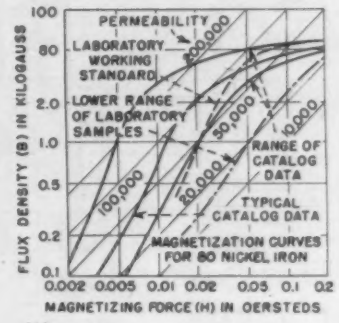
Characteristics of Rectifiers

The performance of the rectifiers used in saturable reactor systems, particularly those employing the self-saturation feature, affects the characteristics of the circuit. The question of rectifier performance is one which parallels in importance that of the magnetic properties of the core materials. Explicit characteristics desired of rectifiers for magnetic amplifier applications are: (1) sturdiness and (2) low forward combined with high back resistance.

Sturdiness, reliability and long life are essential because magnetic amplifier applications often involve conditions of high-intensity shock and require operation without replacement of parts or servicing for 10,000 hours or more. Because none of the components, except possibly the rectifier, are difficult of manufacture to meet these requirements,







STATIC CHARACTERISTICS OF COMMERCIAL SELENIUM AND GERMANIUM RECTIFIER CELLS

TYPE	SELENIUM SINGLE CELL	GERMANIUM CRYSTAL DIODE
RATED FORWARD CURRENT	40 MA	22.5 MA
PEAK INVERSE VOLTAGE	18 VOLTS	50 VOLTS
FORWARD RESISTANCE	20 OHMS AT 40 MA	75 OHMS AT 22.5 MA
INVERSE RESISTANCE	22,500 OHMS AT 18 VOLTS	150,000 OHMS AT 50 VOLTS
RECTIFICATION RATIO	1,125	2,000
RATED FORWARD VS INVERSE CURRENT AT RATED VOLTAGE	50	65

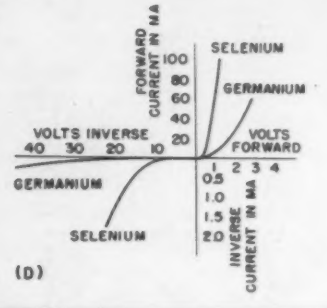


FIG. 3—(A) Core material and circuit determine response of amplifier. (B) Positive feedback gives snap action; negative feedback improves linearity. (C) Properties of cores vary between samples. (D) Rectifiers are also important

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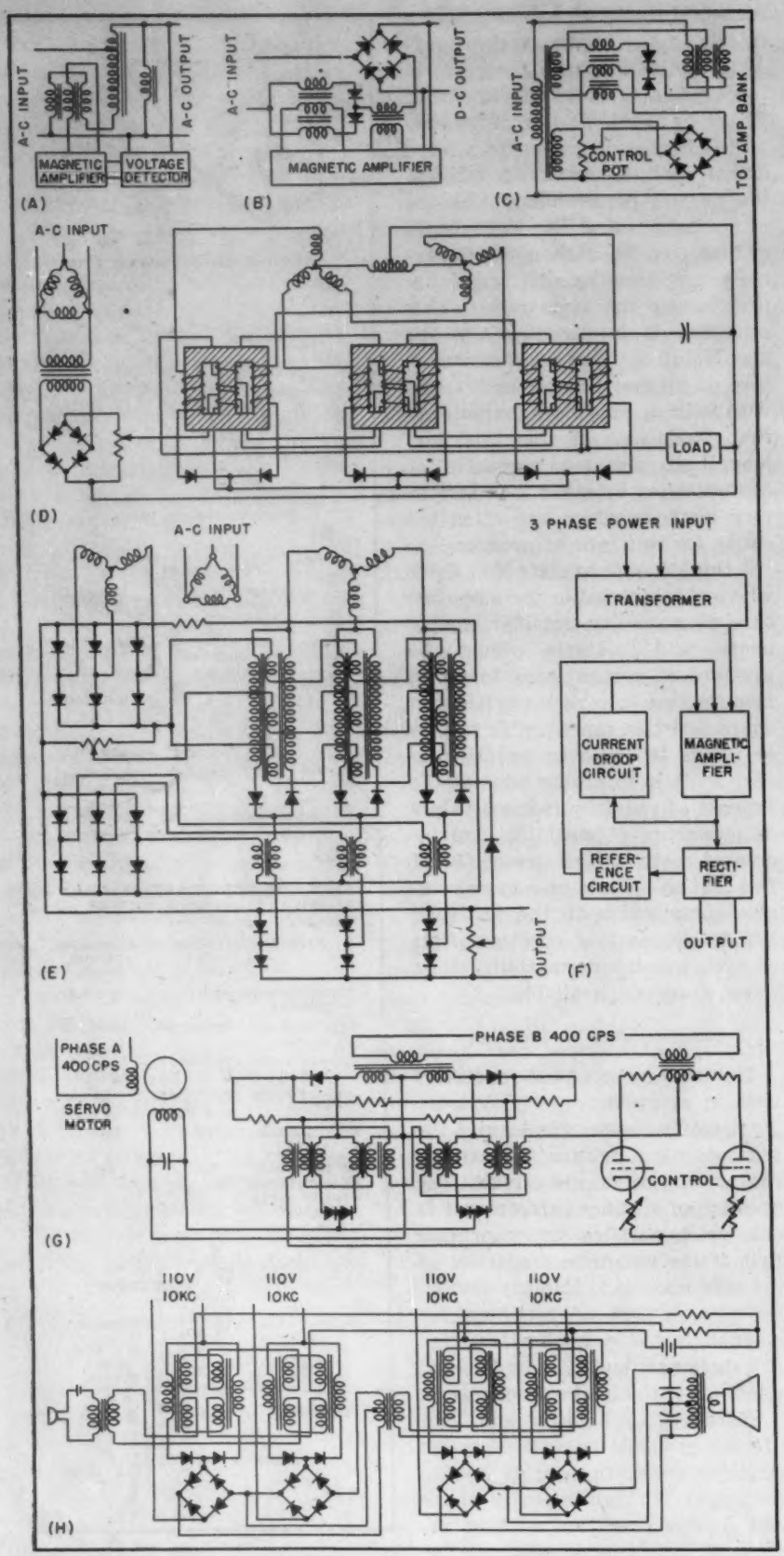

FIG. 4—Presaturated reactors and magnetic amplifiers have been used in various applications, as these simplied diagrams show: (A) line voltage regulator, (B) automatic battery charger, (C) theater lighting control, (D) constant potential rectifier, (E) welding rectifier, also shown in block form (F), (G) servo motor power amplifier, and (H) two-stage audio amplifier

the use of dry-disc rectifiers rather than electronic units is usually indicated. At any rate, they are in common use in magnetic amplifier circuits.

Low forward resistance and high inverse resistance are desirable for obtaining maximum sensitivity consistent with the properties of the magnetic core material. Low forward resistance results in an increase of output for a given control signal. The lower back current resulting from the use of high inverse resistance rectifiers results in less demagnetization output for a given control current.

Figure 3D shows the characteristics of two small, commercial rectifiers. The rectification ratios are seen to lie between 1,000 and 2,000, while the forward-versus back-current ratios are 50 and 65. It is desirable for magnetic amplifier circuits that the current ratio be raised to 500 to 1,000. Such a ratio is not considered unobtainable for special-purpose units by rectifier manufacturers. Commercial requirements in the field of dry-disc rectifier units have been so unlike those for the special units discussed, that there has been little development work aimed at the special characteristics required of rectifiers for reactor circuits. No doubt such improvement in rectifiers can be made without an overly extended development program.

Rather large changes of operating temperature should not be reflected in equivalent changes of electrical characteristics of the rectifiers, particularly the inverse resistance, nor should the rectifier characteristics change radically over the period of their useful life. Rectifiers should have the maximum inverse voltage rating consistent with a high value of forward-versus back-current ratio so that they are light in weight and give optimum amplifier sensitivity. They should not change when unused or should recover rapidly from nonuse such as shelf storage or equipment idleness. Like core materials, rectifiers for magnetic amplifiers should have reproducible characteristics as commercially available units with published resistance characteristics. This requirement is particularly true of the low-level units, espe-

cially sensitive types, but is not of great consequence at higher power levels, present published rating data being sufficient.

Applications of Magnetic Amplifiers

Just as the saturable reactor is a basic component of the magnetic amplifier, so the magnetic amplifier can be used as a basic subassembly in various equipments. The characteristics of the amplifier will be determined by the equipment with which it is to be used, and the amplifier will have to be designed accordingly.

One of the commonest applications of saturable reactors is for line voltage regulation in which the self-adjusting property of the reactor is used in place of a manually adjusted tap on a transformer to compensate for input voltage or load current changes. The next step in complexity beyond a single saturable reactor is to substitute a separately controlled reactor (Fig. 4A). Line-to-line voltage regulation is obtained by an autotransformer a portion of which is a presaturated reactor controlled by a magnetic amplifier operating from voltage changes across the output. A bleeder reactor prevents the regulator from losing control at no load.

Automatic battery chargers have long used magnetic amplifiers, especially in Europe. In this application the requirement is to maintain constant charging voltage and to limit the current (at the beginning of the charging cycle) to a safe value. A doubler circuit (Fig. 1D) and a full-wave rectifier can be combined to perform this function (Fig. 4B). Variations in output voltage and input current (coupled to the magnetic amplifier through a transformer) operate the control winding.

Another popular application is in theatre lighting control (Fig. 4C). A low-power control circuit, excited from the power line, produces the direct current to govern a magnetic amplifier of the full-wave type (Fig. 1E), which is also excited from the power line. The output of the amplifier in turn regulates the saturation of the main reactor in series with the lamp bank. Because the primary control circuit and the magnetic amplifier are both excited from the same power line, effects of fluctuations in supply voltage can be counter-acted to some extent. The line voltage has to be about 10 percent higher than the rated operating voltage of the lamp bank to allow for the drop in the main reactor.

The functions of voltage regulation and rectification can be combined in a single unit. A 3-phase unit, suitable for such applications as controlling the speed of a large d-c motor, (Fig. 4D), obtains the fixed reference voltage through a constant voltage transformer across one of the power phases. This voltage is rectified and the current so obtained is used to control three full-wave magnetic amplifier operating from a 3-phase transformer and interphase transformer (compare with the single-phase circuit of Fig. 1E). To increase the sensitivity of the system, positive feedback is used, and to improve transient response, damping windings in series with a capacitance are added. The output voltage (motor speed) can be controlled by the potentiometer in the constant-voltage circuit.

Some applications require that the output be stabilized against several possible variations. The battery charger (Fig. 4B) is one example of this case. The welding rectifier (Fig. 4E) is another example. The output current must be stabilized against changes in output load (current and voltage) and line voltage. The 3-phase doubler circuit has three control windings. One winding is excited by rectified 3-phase voltage from the supply line, the second is excited by current proportional to the load current, and the third by current proportional to the load voltage. All of these control currents pass through a common potentiometer by which the welding current can be set. A potentiometer across the output further provides adjustment of the voltage-proportional control current for no-load reference. Four sets of rectifiers are required: the self-excitation rectifiers of the doublers, the power rectifiers in the output, and the two sets of rectifiers (for input voltage and output current) for the control windings. A single rectifier suffices for the output voltage control circuit because it is already across the power rectifiers (but a rectifier is necessary to provide high impedance to induced reverse currents). A block diagram (Fig. 4F) shows the nature of the feedback paths of this system.

The foregoing systems have operated at 60 cps. Fast response is not required of them and it is most convenient to excite all elements of the system from the same supply. However, if fast response is necessary, a higher operating frequency should be used because then, for the same impedance, the inductances of the windings can be less, which reduces the time constant of the system. In general, equivalent magnetic amplifiers operating at different frequencies can respond in the same number of cycles, thus the higher frequency unit has the faster response.

A fast-acting servo amplifier can be operated from a 400-cps. source (Fig. 4G). A 2-phase system is frequently used with a 2-phase induction motor, although a 3-phase system would be similar. Doublers in push-pull with each other produce a null so that the system has a quiescent point between forward and reverse motor drive. The control windings are excited by electronic tubes; the rheostats in the cathodes permit balancing the amplifier at the required null, or varying the null. Primary control of the amplifier is, as usual, through the grids of the tubes.

An audio amplifier (Fig. 4H) illustrates the use of high-frequency excitation to obtain fast response. Essentially each of the two stages is a carrier-type amplifier. Two pairs of doublers, connected in push-pull to reduce even harmonic distortion as well as to provide symmetrical operation, are excited from a 10,800-cps source (180th harmonic of 60 cps). These two stages are connected by an interstage transformer. Pairs of full-wave rectifiers are used before the interstage and output transformers. A single-button carbon microphone feeds the 5-milliwatt input transformer to develop full power in the 5-ohm 6.5-watt voice coil of the loudspeaker. The operating points of the reactors of each stage are set by a bias battery and biasing resistors.

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Television Synchronizing Si

Horizontal and vertical driving pulses, the composite blanking signal and the composite synchronizing signal, all within FCC and RMA specifications, are produced. Linearity test signals can be mixed with blanking for testing picture monitors and receivers; simultaneous cathode-ray monitoring of all frequencies is provided

THE instrument to be described provides the means for insuring synchronism between the scanning of a picture at the receiver and the scanning of a subject at the transmitter. Features are provided that are not usually found in a synchronizing generator which are specific aids in television station operation and maintenance.

The generator meets the RMA recommendations for the standard signal, that is, the horizontal and vertical driving pulses, the composite blanking signal and the composite synchronizing signal.

Linearity test signals are provided at 900 cycles and at 157.5 kc mixed with blanking by means of a switch for use in testing scanning linearity of picture monitors and television receivers. These produce 15 horizontal bars and 10 vertical bars on a raster permitting a rapid check of sweep linearity. In addition, the 157.5-kc test signal serves as an accurate 10 percent H (6.35 μsec), electronic marker for use with an ordinary oscillograph in the precise setting of pulse widths and front porch.

The leading edges of the equalizing pulses are also the leading edges of horizontal and vertical synchronizing pulses, thus insuring perfect interlacing.

Two 3-inch cathode-ray tubes permit simultaneous monitoring (without switching) of all frequencies in the synchronizing generator. Thus, frequency counts may be checked or adjusted without the use of an external oscilloscope.

A crystal oscillator at 157.5 kc or a highly stable self-excited oscillator at 157.5 kc may be selected by a switch for the master oscillator. The self-excited oscillator is used in synchronizing the generator, by means of the provided lock-in circuit to the 60-cycle power line or to a remotely generated synchronizing signal.

Negative feedback is used in many of the circuits to minimize the effect of changes in tube characteristics and variations between tubes. A double-regulated supply is used having an internal impedance of less than 0.15 ohm.

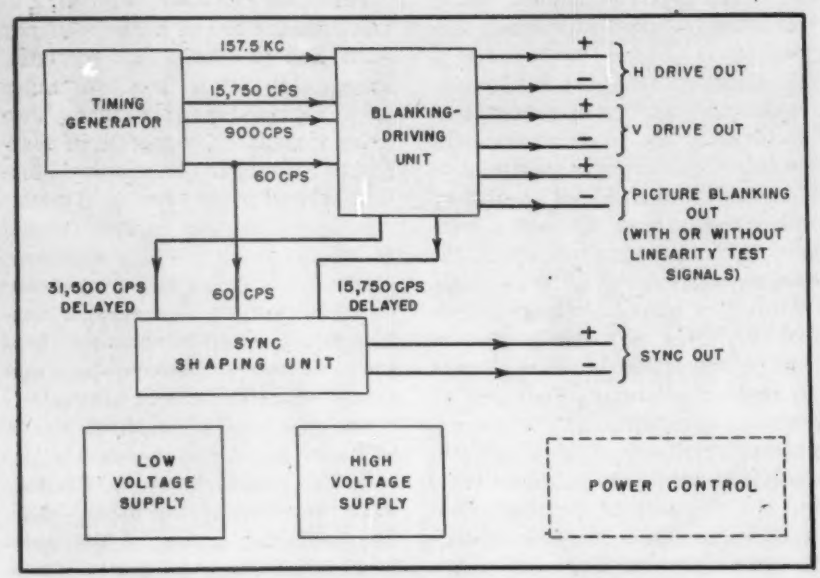

FIG. 1—Interrelation of units forming the sync generator

Circuit Breakdown

The generator consists of the following units:

1. Timing generator
2. Blanking-driving unit
3. Sync shaping unit
4. Regulated low-voltage supply
5. High voltage supply for the cathode-ray monitors
6. Power control panel containing switches and fuses.

Figure 1 is a block diagram showing the interrelation of the units in the development of the standard signals. Accurately timed signals at 157.5 kc, 31,500 cycles, 15,750 cycles, 900 cycles and 60 cycles are developed in the timing generator for use in the other units.

The blanking unit utilizes the 60-cycle signal and the 15,750-cycle signal in the development of verti-

Signal Generator

By A. J. BARACKET

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Television Transmitter Division
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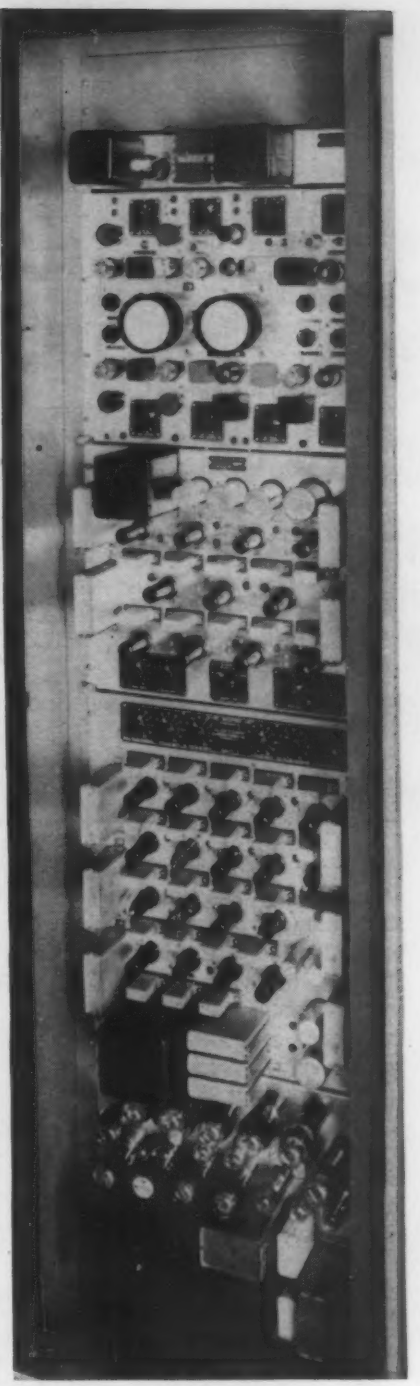

Complete synchronizing signal generator

cal driving and horizontal driving pulses and in the development of the composite blanking signal. It also uses the 157.5-kc signal and the 900-cycle pulses in the development of the composite linearity test signal which becomes available mixed with blanking.

The sync shaping unit utilizes the 31,500-cycle pulses and the 15,750-cycle pulses with suitable delays (for accurate synthesis of the horizontal and vertical sync pulses) in a specially designed delay line contained in the blanking-driving unit for the formation of the high-frequency components of the composite synchronizing signal. The 60-cycle pulse from the timing generator is used undelayed in the development of the low-frequency component of the composite synchronizing signal.

To meet the severe requirements of the RMA-recommended synchronizing signal generator signals, there must be precise time relationship among the pulses developed by the timing generator. This may be obtained by starting at a high frequency and by suitable frequency division deriving the lower frequency pulses. An alternate method is to begin with the lowest frequency and obtain the higher frequency signals by suitable frequency multiplication. In the timing generator shown in Fig. 2, the former method is used because it may be effected by simpler circuits.

In the circuit diagram of Fig. 2, the two basic oscillators are the 6AC7 crystal oscillator and the 7F8 master oscillator, both operating at 157.5 kc. The 6SN7 blocking oscillator frequency dividers are used to derive the lower frequencies required. The first division is by 5 to 31.5 kc, the equalizing pulse frequency. From 31.5 kc there is one division by two to 15,750 cycles, the horizontal rate, and another division by seven to 4,500 cycles. The frequency of 4,500 cycles is divided by five to 900 cycles, one of the linearity test signal frequencies.

Division of 900 cycles is done by five to 180 cycles which is in turn divided by three to 60 cycles, the field repetition rate. Sawtooth wave forms at 60 cycles and at 900 cycles are fed respectively to the deflecting plates of the low-frequency and the high-frequency cathode-ray monitors, to serve as time bases for the presentation of the count-down frequencies on the monitor screens.

Frequency Indicators

Figure 3 shows the presentation on the screens of the cathode-ray tubes. The left-hand screen is that of the high-frequency monitor whose horizontal time base is 900 cycles. The dots represent the master oscillator or crystal oscillator frequency 157.5 kc. There are five dots along each line or step in the vertical "ladder" indicating a division from 157.5 kc to 31,500 cycles.

The bright dots on the high-frequency monitor correspond to the 15,750-cycle horizontal repetition rate. There are seven steps in each of the ladders, indicating a frequency division from 31,500 cycles to 4,500 cycles; in other words each ladder represents 4,500 cycles. The presence of five ladders for each cycle of the time base points to a frequency division from 4,500 cycles to the time base frequency of 900 cycles.

On the right-hand or low-frequency monitor, the ladder steps represent 900 cycles. Since there are five of them to each ladder, the indication is frequency division

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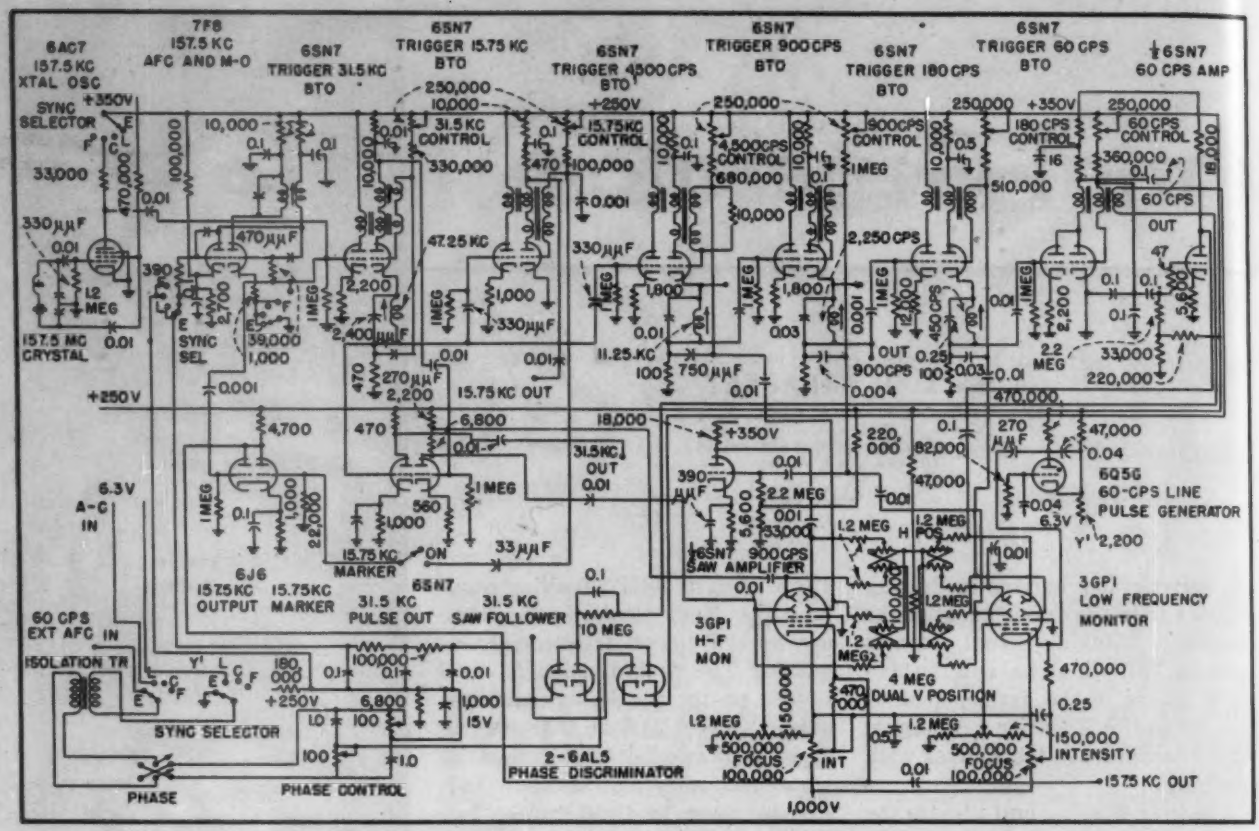

FIG. 2—Timing generator circuits of the Du Mont TA107 A/B sync generator

from 900 cycles to 180 cycles. The three ladders per cycle of the time base indicate a frequency division from 180 cycles to 60 cycles.

The blanked out section in the middle of the low-frequency scan being derived from the power line further confirms the time base of 60 cycles and indicates synchronism with the line. When the generator is not locked to the 60-cycle power line, the blanked out section moves across the time base. This presentation has been found highly useful in the analysis at a glance of synchronizing generator failures due to improper timing.

The type of blocking oscillator frequency divider circuit used is the cathode - tuned - circuit - stabilized type, Fig. 4. Firing of the blocking oscillator results in a surge of current through the cathode circuit which is normally tuned to a frequency half that of the trigger repetition rate. This results in a ringing of the tuned circuit due to its Q. The cathode voltage wave form is that of a damped sine wave lasting for 2½ cycles (for a 5 to 1 count down) before the blocking oscillator fires again. The grid to ground and the grid to cathode voltage waveforms are shown in the diagram of Fig. 4. As indicated, discrimination is very good against all trigger pulses other than the one producing proper count down.

In the design of the timing circuits, extreme care was taken to minimize any possibility of frequency modulation of the timing pulses. Considerable attention was paid to the chassis layout especially with respect to keeping high level pulse points away from the afc circuit. The blocking oscillator grids are returned to +250 volts giving a steep capacitor voltage discharge waveform and consequently improving freedom from jitter.

The source of B voltage is a double-regulated power supply with an output impedance of less than 0.15 ohm. This eliminates the possibility of extraneous signals modu-

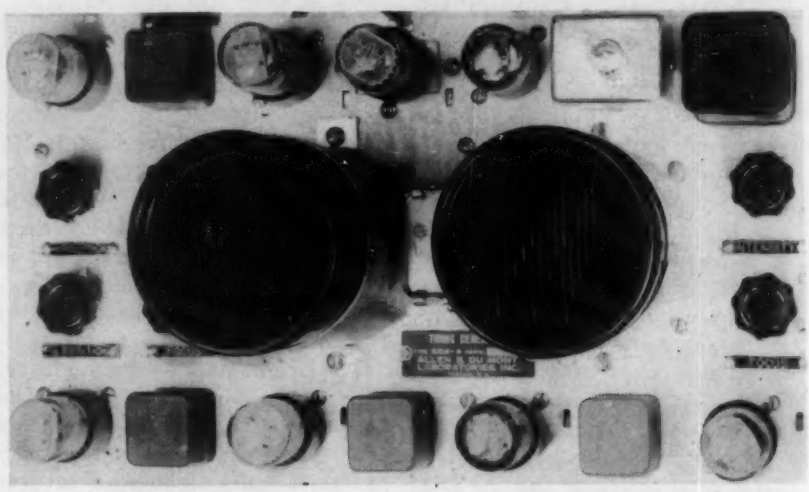

FIG. 3—Presentation of count-down frequencies on cathode-ray monitors

lating the blocking oscillator grid base, a common source of frequency modulation.

The 157.5-kc and 900-cycle outputs of the timing generator are fed directly to the blanking unit for use in the production of a linearity test signal mixed with blanking. The 60-cycle pulse output of the timing generator is routed to the blanking-driving unit and the sync shaping unit for use in the generation of RMA driving pulses, and the low-frequency components of RMA blanking and sync pulses.

To conform to the strict requirements of the RMA recommended synchronizing signal, it is good design practice to use the same signal for the formation of the leading edges of all of the pulses which make up the synchronizing signal. In the synchronizing signal generator under discussion, the leading edges of the equalizing pulses are used to form the leading edges of the horizontal and the vertical synchronizing pulses. This is done by adding a horizontal component and a vertical component, both of which have been delayed a precise time by a lumped LC delay line in the blanking unit, to the equalizing pulses and clipping the result as indicated in Fig. 5.

Two separate delay lines are used, one for the 31,500-cycle signal and the other for the 15,750-cycle signal. Each line consists of 70 π sections with a total delay of 10 percent of the horizontal period or approximately 6.3 microseconds. Provisions are made for tapping connections in any one of the sections in both lines. This permits very accurate shaping of the sync pulses as well as very precise setting of the front porch. Multivibrator stability is in part a function of the trigger pulse rise time. To maintain as short a rise time as practical in the delayed 15,750 and 31,500-cycle trigger pulses, the delay line is designed for a frequency band of over three megacycles. Figure 6 shows the schematic of a single section of the delay line.

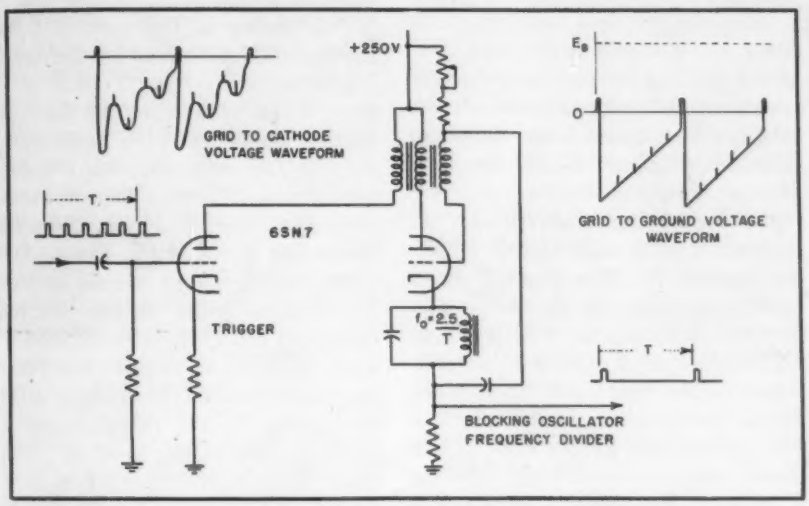

FIG. 4—Cathode-stabilized blocking oscillator frequency divider

Equalizing Pulses

The equalizing pulses shown as *G* in Fig. 5 are generated directly by multivibrator V_{17} in the sync shaping unit, block diagram of Fig. 5. They are amplified and limited by V_{18} and mixed with the

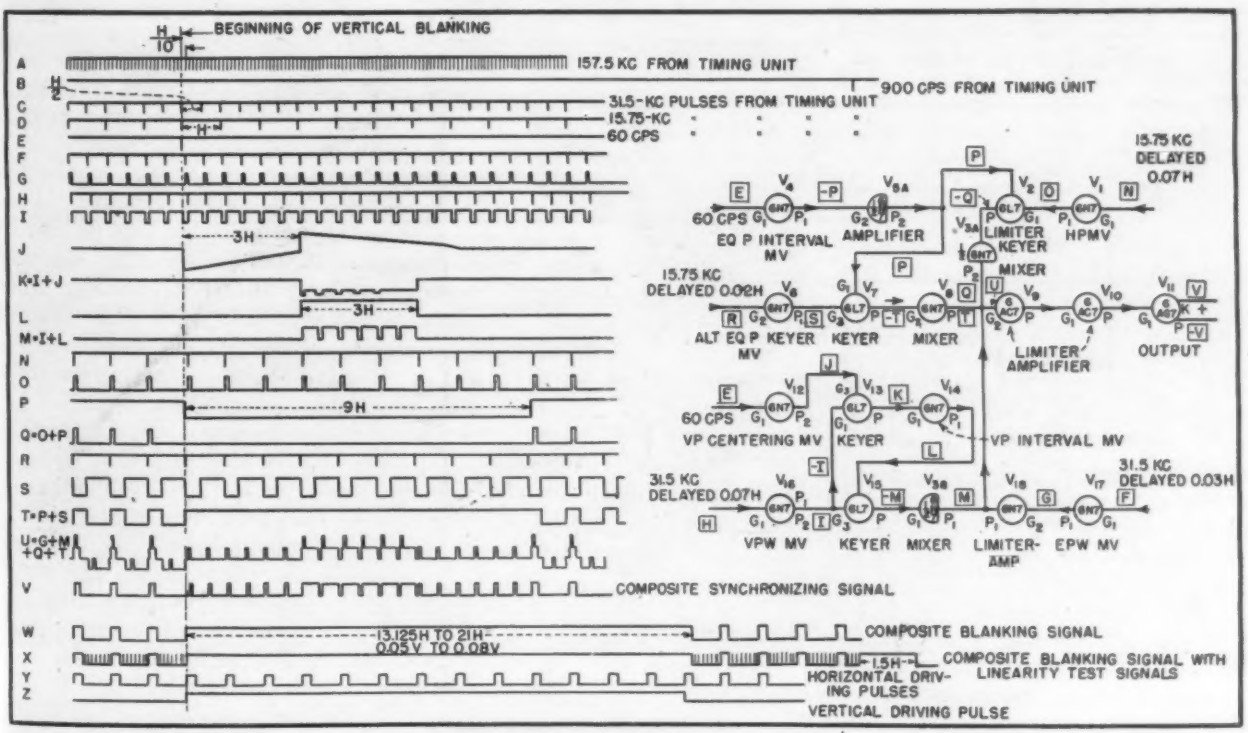

FIG. 5—Timing diagram shows the formation of the composite synchronizing signal and block diagram of sync shaping unit

other synchronizing signal components in the plate circuits of V_{12} V_8 and V_9.

Horizontal Pulses

Figure 5 is a timing diagram indicating the synthesis of the composite synchronizing signal from its various components. The horizontal pulses are formed by adding delayed 15.750-cycle pulses to the equalizing pulses, amplifying, limiting and keying-out undesired 31,500-cycle pulses. The result before final clipping is shown at U of Fig. 5.

Tube V_1 in Fig. 5 is the horizontal pulse multivibrator whose output (O in Fig. 5) is permitted to clear through V_2 only during the horizontal pulse interval.

The 15,750 cycle pulses (Q in Fig. 5) are then amplified and limited in V_3 and mixed in the common plate circuit of V_{12} and V_9 with the vertical and equalizing pulse components of the composite synchronizing signal.

The first and last sections of U in Fig. 5 show the horizontal component of the mixed signal at V_9. The raised portion of this component indicates the overlap between the equalizing pulse and the delayed horizontal pulse. This is later clipped off in limiters V_9 and V_{10} as shown in the first and last sections of V in Fig. 5.

The keying out of the horizontal pulses during the equalizing pulse interval is accomplished by the gating of keyer tube V_2 by pulse P in Fig. 5 derived from the equalizing pulse interval multivibrator V_4 through amplifier V_5. The elimination of unwanted equalizing pulses is obtained by first pushing them down into a region lower than that of the desired horizontal pulses by means of 15,750-cycle pulses shown as T in Fig. 5 and later removing them by clipping. Waveform T is derived from the alternate equalizing pulse keying multivibrator V_6 through keying tube V_7 and amplifier-limiter V_8. The pushed down equalizing pulse is shown in the first and last sections of U in Fig. 5.

The elimination of alternate equalizing pulses must not take place during the equalizing pulse interval. For this reason keying tube V_7 by means of the equalizing interval pulse P permits the alternate equalizing pulse keying signal S to be applied only during the horizontal pulse interval. The output of V_7 is T in Fig. 5. The duration of the horizontal pulses in the output signal V is 8 percent of H (+0 −1 percent).

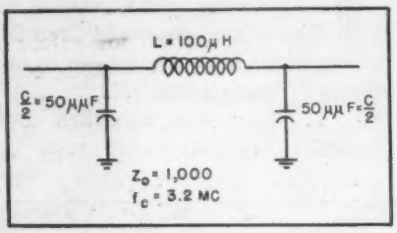

FIG. 6—Single pi section of delay line

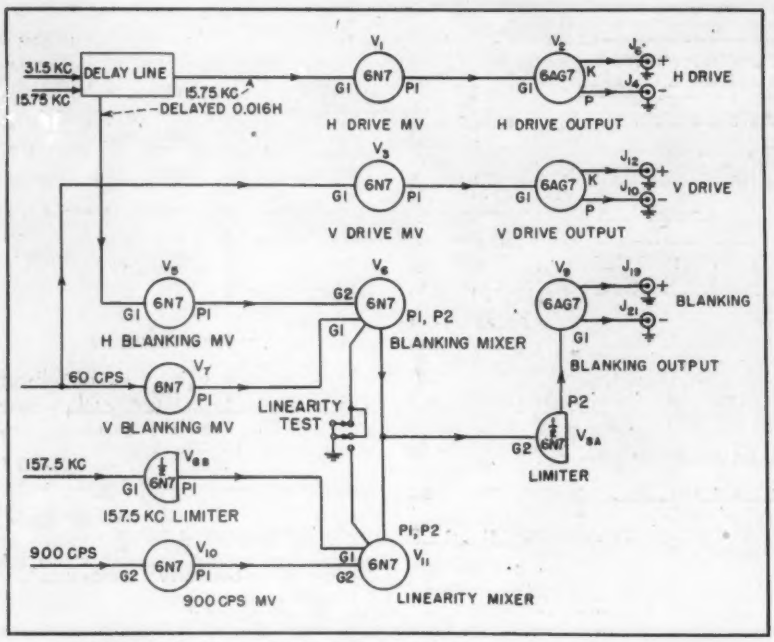

FIG. 7—Functions of stages in the blanking-driving unit

Vertical Pulses

The vertical pulses in the composite synchronizing signal consists of a group of six at a 31,500-cycle rate. The group repeats itself once each scanning field, see center section of V in Fig. 5. The duration of each pulse is 43 percent of H where H is the line period and the group must appear during the vertical blanking interval between the first and second group of six equalizing pulses.

The timing of the vertical pulse interval is determined by the trailing edge of a pulse, J in Fig. 5, three lines wide from the 60-cycle vertical pulse centering multivibrator V_{13}. The vertical pulses are generated at a 31,500-cycle rate in the vertical pulse multivibrator V_{14}. These are shown at I in Fig. 5. One of its pulses, upon coincidence with the trailing edge of the vertical centering pulse K, is permitted by keyer tube V_{15} to trigger the vertical pulse interval 60-cycle multivibrator V_{14} whose pulse width is normally set equal to three horizontal lines or the interval required by six vertical pulses at the 31,500-cycle rate.

Waveform L in Fig. 5 is the output of V_{14}. The vertical pulse interval gate, in turn, permits the vertical pulses to be amplified by keyer tube V_{16} only during the vertical pulse interval. The result is M in Fig. 5. In turn, the six vertical pulses during the vertical pulse interval are amplified and limited by tube V_3 and appear in the common plate circuit of V_3, V_8 and V_{12}. Thus, into a common plate load are fed the horizontal pulses during the horizontal pulse interval from tube V_3, the equalizing pulses during the equalizing pulse interval from tube V_{12} and the six vertical pulses during the vertical pulse interval from tube V_8. The mixed signal, U, is amplified and limited by V_9 and V_{10} and appears at the cathode and plate of output tube V_{11} as a positive and negative composite synchronizing signal. Figure 5 shows the final sync output signal at V.

The block diagram of the blanking-driving unit is shown in Fig. 7.

The 15,750-cycle pulses trigger the horizontal blanking multivibrator V_8 whose output is fed into blanking mixer V_9. The 60-cycle pulses trigger the vertical blanking multivibrator V_7 whose output is fed to the grid of the second triode of blanking mixer V_6. In the blanking position of the linearity test switch, the mixed vertical and horizontal blanking signals are limited and amplified in tube V_{8A} and applied to the grid of blanking output tube V_9. At the cathode and plate of output tube V_9, appear respectively the positive and negative composite blanking signals.

The 157.5-kc signal derived from the timing generator is amplified and shaped in V_8 and mixed in V_{11} with the 900-cycle pulse derived from multivibrator V_{10}. In the *blanking and linearity bars* position of the linearity test switch, these are inserted into the blanking signal in the common plate load of blanking mixer V_6 and linearity mixer V_{11}. The mixed blanking and linearity test pulses are clipped in limiter V_{8A} and applied to the grid of output tube V_9. In this position of the switch the output signals at J_{19} and J_{21} consist of the composite blanking signal mixed with vertical and horizontal linearity signals. In the *linearity bars* position of the selector switch only linearity test signals are permitted to appear at the blanking signal output jacks. Figure 8 shows a test pattern generated by an iconoscope film chain driven by the sync generator. The linearity test switch is in the *blanking and linearity bars* position.

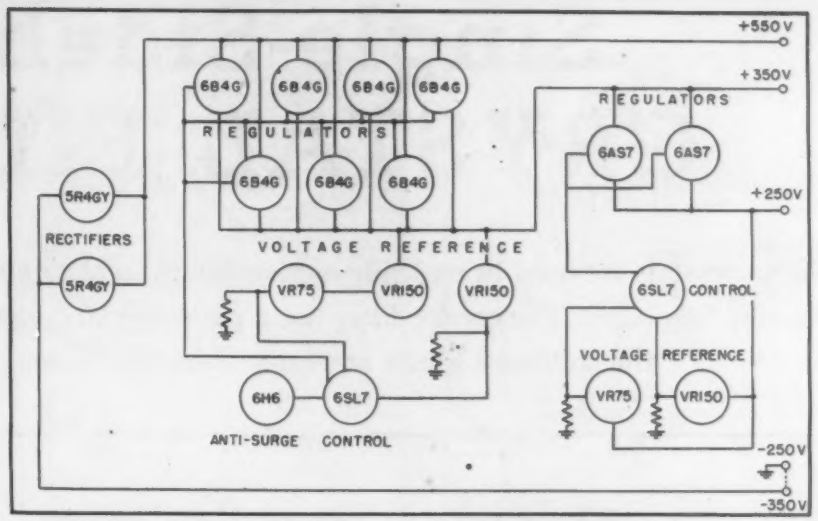

FIG. 9—Block diagram of low-voltage power supply

The horizontal driving pulses originate in the 15,750-cycle multivibrator V_1 and are directly applied to the grid of the horizontal drive output tube V_2. They appear as positive and negative horizontal driving signals respectively at J_6 and J_4. In a similar manner the vertical driving pulses originate in the 60-cycle multivibrator V_3; the output is applied directly to the grid of vertical output tube V_4. Vertical driving pulses appear in positive and negative polarity at jacks J_{12} and J_{10}. At *Y* and *Z* of Fig. 5 are shown the waveforms of the horizontal and vertical driving pulses produced by the circuits.

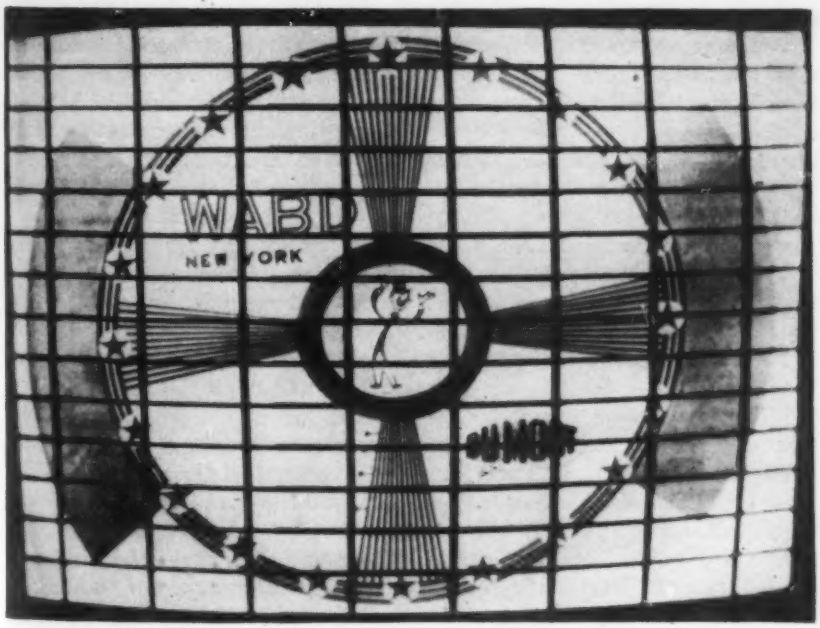

FIG. 8—Camera chain output picture signal with the linearity test switch of sync generator set at blanking and linearity bars for adjustment of monitor sweep linearity

Power Supplies

The high-voltage supply is used to provide the accelerating potential for the cathode-ray tube monitors in the timing generator.

A double-regulated low-voltage supply is used to provide 250 volts and 350 volts for the three signal units. This supply has an output impedance of less than 0.15 ohm at 1,000 cycles. The change from no load to full load at 400 milliamperes results in a change of only 0.1 volt at the output. A block diagram of the low-voltage supply is shown in Fig. 9. Transients from the ordinary power supply filter circuit are eliminated by use of an "electronic choke" in the form of a first regulator for the 350 volts ahead of the final regulator for the 250 volts.

A number of these synchronizing generators have been in operation during the past two years with excellent results.

Acknowledgment

Acknowledgment is made to the following men of the Du Mont Laboratories who took part in the development and product design of the synchronizing generator: H. Beste, L. Durgin, C. Quirk and L. Spooner, and to N. Accardo and M. Demeyer, who aided materially in the test of models.

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Single-Sideband CRYSTAL FILTERS

X-cut crystals are used in multiple-section filters for the upper and lower sidebands and the carrier frequency. The carrier filter has a passband 16 cycles wide between 3-db points and the sideband filters are flat within 0.6 db for nearly 6 kilocycles

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Camden, New Jersey

ONE PROBLEM involved in the development of an improved type of radio receiver for twin-channel, single-sideband reception was the design and construction of three crystal filters.

These were used to separate the carrier from the sidebands of an amplitude-modulated wave train at an intermediate frequency of 100 kc and to isolate each of the two sidebands.

Specifications called for a carrier filter less than 25 cycles wide at points whose response was 3 db down from maximum, and 175 cycles wide at points 50 db down, with a maximum attenuation of over 70 db available.

Since both speech and musical programs were to be received with high fidelity, each sideband (channel) filter was specified to have a passband 6 kc wide, flat within ±0.5 db except at the edges where a 2-db drop from maximum response could be tolerated. These edges were taken to be 100 cycles and 6 kc respectively from the intermediate carrier frequency of 100 kc.

A maximum relative attenuation of at least 85 db was desired at all frequencies separated by more than 4 kc from the passband midfrequency. This would provide for a 40-db attenuation of adjacent-channel signals of equal strength in addition to a possible unfavorable selective fading differential of 45 db between the two channels.

A piezoelectric crystal such as quartz acts electrically[1] like the LC circuit shown in Fig. 1. For a range near the resonant and antiresonant frequencies of this electrically equivalent circuit, the crystal presents a reactance whose variation is shown by the full-line graph of Fig. 4. Suppose that two crystals are so cut that the resonant frequency of one coincides with the antiresonant frequency of the other. The reactances of both crystals are then as depicted by the full-line and dashed-line graphs of Fig. 4.

Theory

If these crystals be connected in a bridge circuit similar to Fig. 6, or its equivalent lattice, Fig. 2, we have the structure of a simple narrow bandpass filter. The dashed-lines in Fig. 2 indicate lattice arms of the same type as those actually shown. In Fig. 6, the dashed-lines indicate that *XX* are the two halves of a single crystal having divided plating. Likewise for *YY*.

The bridge circuit of Fig. 6 is that of a pure reactance bridge. This will be perfectly balanced when the reactance between points 1 and 2 of the circuit is equal to that between 1 and 4 and of the same sign. The same is true for the reactance between 2 and 3 and that between 3 and 4. There are two frequencies at which this will occur. On Fig. 4, these are designated $f\infty_1$, and $f\infty_2$, for the attenuation (theoretically) reaches an infinite value at these frequencies. Actually, the attenuation will merely rise to a maximum value, called an attenuation peak, at each of the two frequencies of balance as shown in Fig. 5. As the frequency of an input signal is increased from $f\infty_1$, toward f_A, the attenuation will continuously decrease until it (theoretically) reaches zero at f_A, the series-resonant frequency of one of the pairs of crystals.

For frequencies between f_A and f_B the reactances of the two pairs of bridge arms are at each point of opposite sign. Hence, signals whose frequencies lie within this range will pass through the filter (theoretically) with no attenuation. Actually some attenuation is experienced in this range, the amount depending on the Q factor of the crystals and associated circuit elements. For this reason, characteristics of the filters developed in this work are shown as relative attenuation versus frequency rather than actual attenuation. The region between f_A and f_B, as shown in Fig. 5, is the passband of the filter.

In practice, capacitors C_A are placed in parallel with input and output terminals of the filter. Others, C_B, of much smaller capacitance, are connected from input to output as bridging capacitors.

The parallel capacitors adjust the separation between resonant and antiresonant frequencies of the bridge arms and hence control the width of the passband. The bridging capacitors change the shapes of the reactance graphs of the bridge arms somewhat, thereby changing the frequencies at which the two reactance curves cross where of like

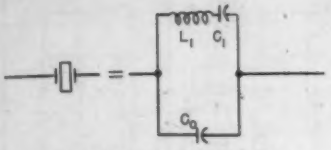

FIG.1-CRYSTAL EQUIVALENT

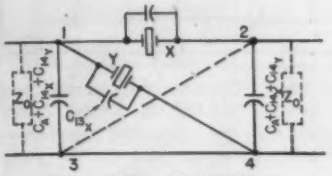

FIG.2-LATTICE STRUCTURE

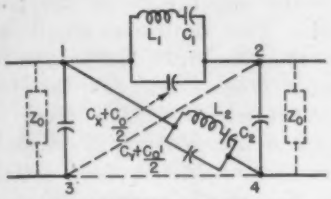

FIG.3-ELECTRICAL EQUIVALENT

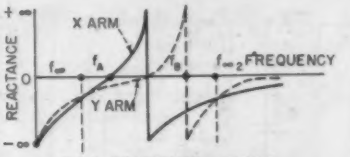

FIG.4-REACTANCE CURVES

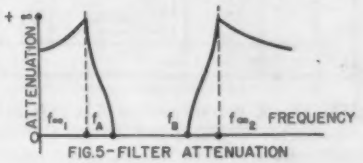

FIG.5-FILTER ATTENUATION

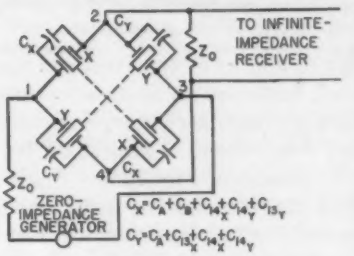

FIG.6-BRIDGE EQUIVALENT

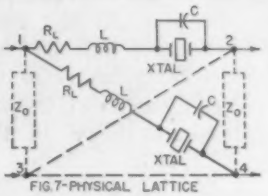

FIG.7-PHYSICAL LATTICE

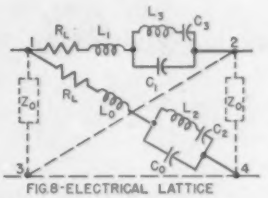

FIG.8-ELECTRICAL LATTICE

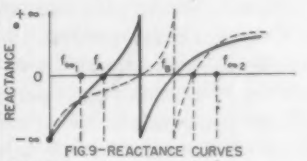

FIG.9-REACTANCE CURVES

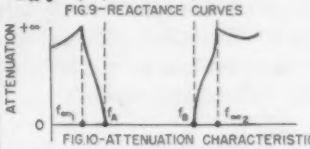

FIG.10-ATTENUATION CHARACTERISTIC

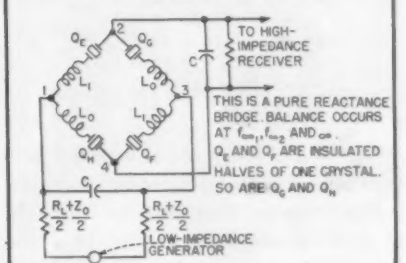
TO HIGH-IMPEDANCE RECEIVER
THIS IS A PURE REACTANCE BRIDGE. BALANCE OCCURS AT f_{∞_1}, f_{∞_2} AND ∞. Q_E AND Q_F ARE INSULATED HALVES OF ONE CRYSTAL. SO ARE Q_G AND Q_H
LOW-IMPEDANCE GENERATOR

FIG.11-BRIDGE EQUIVALENT

Table I—Effect of Temperature on Attenuation Characteristic

db Down	Frequency (kc) of Lower Side		Difference cps	Frequency (kc) of Upper Side		Difference cps
2	93.92	93.93	+10	99.890	99.868	−22
6				100.060	100.035	−25
10	93.58	93.62	+40	100.152	100.127	−25
20	93.41	93.44	+30	100.300	100.278	−22
30	93.29	93.35	+60	100.405	100.360	−45
40	93.16	93.21	+50	100.505	100.480	−25
	Average		+38	Average		−27

sign. Adjustment of the bridging capacitors, therefore, controls the frequencies of the attenuation peaks of Fig. 5.

The resonant and antiresonant frequencies of a quartz crystal are separated by only about 0.4 percent of resonant frequency (for X-cut crystal). Since, as seen in Fig. 4, the passband is only double this amount, some other circuit element must be introduced if wide passbands are desired. Such an element may be an inductance placed in series or in parallel with each crystal of the circuit. These two types of connection result in filters having low image impedance and high image impedance, respectively.

To avoid stray couplings in the channel filters herein described, a reasonably low image impedance was chosen. This choice called for a coil to be connected in series with each crystal of the filter circuit. The widening of the filter passband by the use of coils is due to the fact that their addition produces a large increase in the separation of resonant and antiresonant frequencies of the bridge arms and furthermore extends the upper edge of the passband considerably beyond the higher of the two antiresonant frequencies of the bridge circuit, Fig. 9 and 10.

For the passband region, the image impedance of the filter is a pure resistance whose value changes from near zero at the passband edges to a maximum midway between them. Terminating resistances considerably lower than the midband impedance are used in the filters actually built to secure[3] a better average impedance match over the whole passband.

If all the coils used in the wideband filter are wound to have equal resistances, or if supplementary resistors are inserted to make all arms of the equivalent bridge circuit have equal resistances, it is possible[1] to consider these resistances as being brought outside the bridge circuit proper and incorporated in the terminating resistors. This leaves the bridge as a pure reactance bridge. Under this condition neither the sharpness of the cutoff at the passband edges, nor the steepness of the attenuation characteristic of the filter is impaired by the resistances of the coils inserted in the filter lattice.

Mason[1] has given mathematical formulas from which the values of the circuit components of a filter section can be computed after certain constants have been chosen. These are (1) the frequencies of the edges of the passband, (2) the

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frequencies of the peaks of infinite attenuation, and (3) the midband image impedance of the desired filter. The formulas refer to the electrical equivalents of the crystal filter lattice as shown in Fig. 3 and 8.

A sample 6-kc filter calculation using the wideband filter formulas, resulted in the following values. Chosen

Z_0 = 2,000 ohms
f_A = 99.50 kc; f_B = 106.70 kc
$f\infty_1$ = 98.70 kc; $f\infty_2$ = 107.50 kc; $f\infty_3 = \infty$

Having obtained the values of the equivalent electrical components of a crystal filter section, the next step is to transfer the computed series resonant frequencies f_s and f_s of the crystals to actual dimensions of the quartz crystals themselves. Equations for accomplishing this depend upon the type of crystal cut decided upon.[1, 2]

Calculated

$L_0 = L_1$ = 44.22 mh
C_0 = 52.84 $\mu\mu$f; C_1 = 54.88 $\mu\mu$f
L_2 = 20.73 h; C_2 = 0.1206 $\mu\mu$f; f_2 = 100.70 kc
L_3 = 18.53 h; C_3 = 0.1234 $\mu\mu$f; f_3 = 105.28 kc

The −18.5-deg X-cut crystal had previously been generally used as a filter crystal due both to its high Q and freedom from the troublesome face shear mode of oscillation. However, this cut has quite a large temperature coefficient of over 20 parts per million per degree centigrade.

The +5-deg X-cut crystal with a width-to-length ratio of 0.35 has a temperature coefficient of only about 4 parts per million per degree centigrade.[4] Moreover, it is easily cut from the mother quartz (involving rotation only about the X or electrical axis). It has the disadvantage of having a relatively large coupling to the face shear mode when wide crystals are used.

Because of the two advantages mentioned, the +5-deg X-cut crystal was chosen for the present filter construction. A single-section channel filter was found to have a spurious resonance due to the coupling to the shear mode. The response occurred at a frequency approximately 116 percent of the passband midfrequency and reduced the attenuation to within 11 db of that of the passband itself.

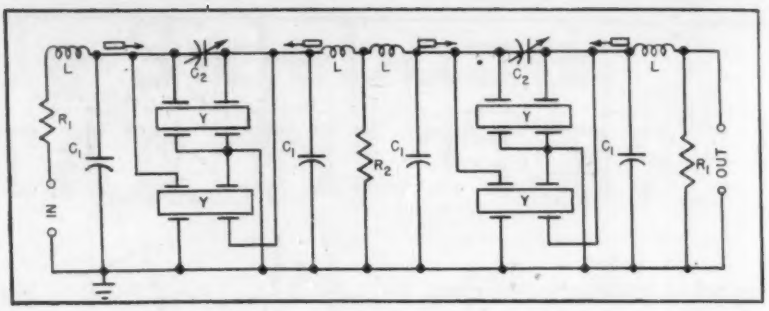
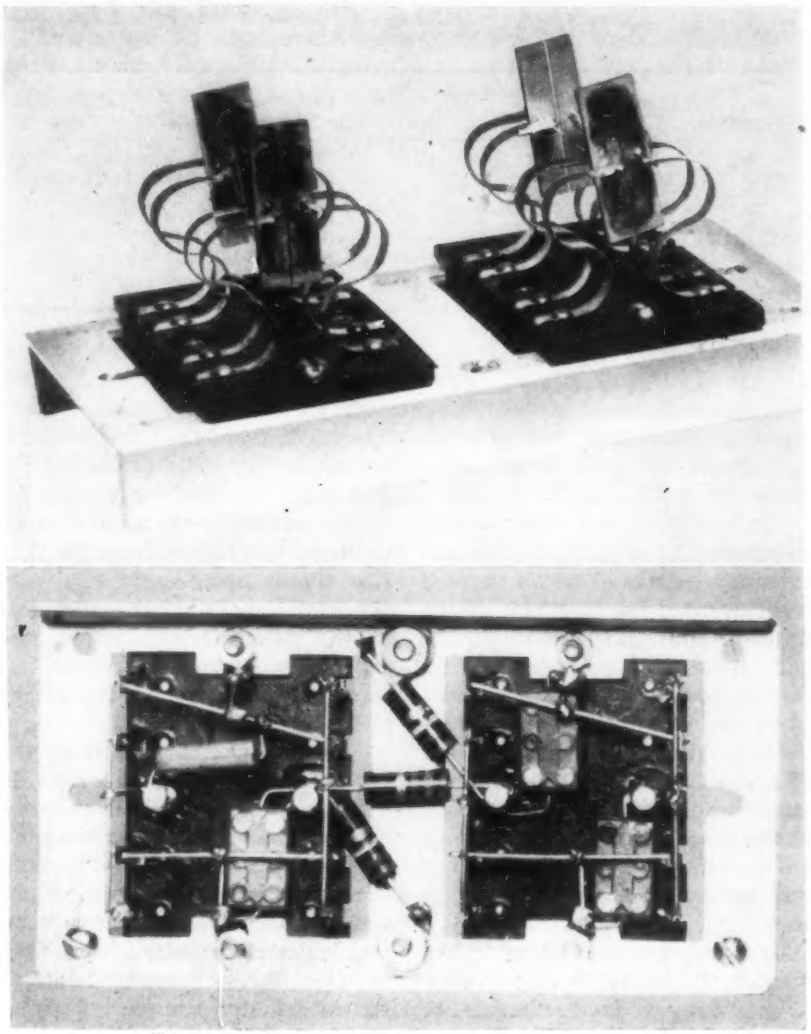


FIG. 12—A double-section 6-kc-channel crystal filter. Capacitors C_1 permit fine adjustment of passband width, C_2 fine adjustment of attenuation peaks, L are passband widening coils, R_1 are terminating resistors, R_2 are interstage impedance-matching resistors and Y are +5-deg X-cut crystals

When a filter of four sections was tested, however, no observable indication of any secondary response at all was present. This is evident in the graphs of Fig. 14 and Fig. 15 where the attenuation is 87 db or greater for all frequencies more than 1.2 kc (1.1 percent) higher than the upper edge of the passband. This desirable result was due to the slight differences in crystal frequencies for the four filter sections resulting from the choice of different peaks of maximum attenuation for each section.

By the use of equations given by



Top and bottom views of two-section 6-kc bandpass crystal filter chassis

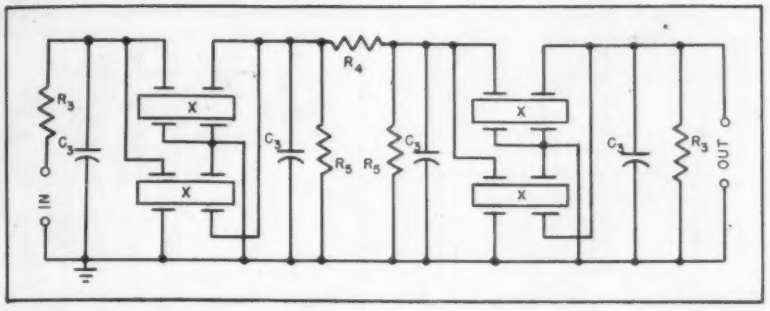


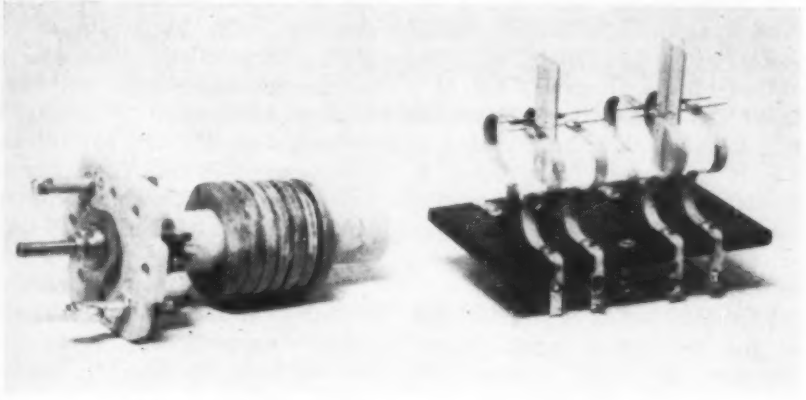
FIG. 13—A double-section 20-cycle crystal filter. Capacitors C_3 control passband width, R_3 are terminating resistors, R_4 and R_5 are interstage impedance-matching resistors and X are +5-deg X-cut crystals. These components are shown in the illustrations on this page

Atwood[3] we find for the +5-deg X-cut crystal that $f = 110.5/y'$ kc.

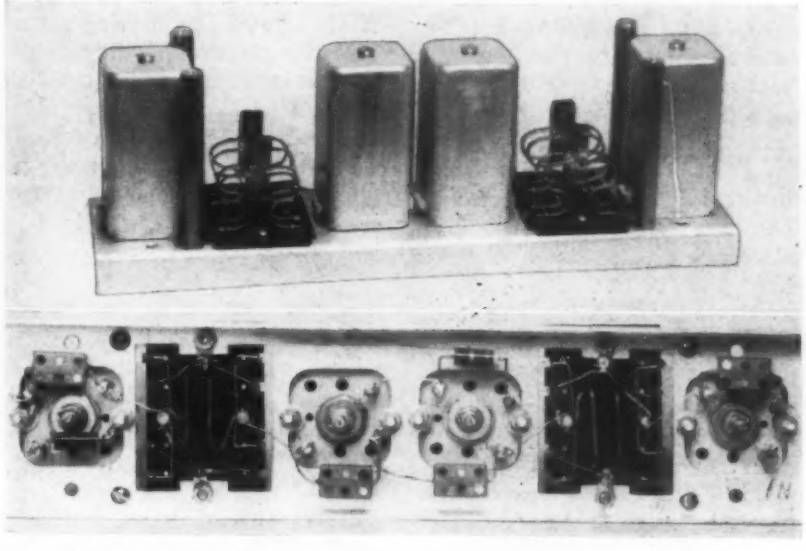
This equation is strictly accurate for only very narrow crystals, of which y' is the length. The crystals were designed to have a width/length ratio of about 0.35 in order to secure the +5-deg X-cut crystal minimum temperature coefficient of 4 parts per million per degree centigrade previously mentioned. As X-cut crystals of larger and larger widths are used, the crystal frequency constant decreases somewhat from that of a very narrow crystal.[5] For a width/length ratio of 0.35 the decrease is 1.8 percent. Hence the equation is modified for the crystals used in the present project to

$$f = 108.5/y' \text{ kc}$$

A preliminary study of the effect of interelectrode and stray capacitances together with midband frequency and bandwidth requirements for the 6-kc bandpass filters dictated the use of very thin crystals. Having chosen a minimum feasible thickness and a width/length ratio of around 0.35 the equivalent motional capacitance of a sample crystal was found by measurement of its static capacitance together with its resonant and antiresonant frequencies. Substitution of this value for C_2 or C_3 in Mason's equations determined the image impedance Z_0 of the filter. This value of Z_0 was, therefore, used in calculating all the electrical components of the 6-kc bandpass filters.



Crystal mounting and coil details for 6-kc bandpass crystal filter



Top and bottom views of two-section 20-cycle filter chassis for 100-kc carrier

Construction of Channel Filters

To obtain the sharp cutoff and large attenuation required by the specifications, a filter of four sections was built for each of the 6-kc channel filters. Two shielding cans were used as containers for each complete filter, each can containing two filter sections. After the filter was mounted, dry air was passed through the can which was then hermetically sealed.

Each single-filter section consists of two crystals with divided plating, two coils in shielding cans, each equipped with adjustable powdered-iron cores, two small, fixed, molded-mica capacitors and a tiny bridging capacitor. The latter is formed by two short lengths of bus bar mounted about ¼-inch apart on the bottom of the Bakelite crystal mounting base.

The circuit of each double-section filter is shown in Fig. 12. Resistor R_2, shunted between the interconnection of each two sections and the chassis, together with the resistances of the input and output coils, provides a T pad to serve for interstage impedance matching. External terminations were used with each double section filter.

Each series coil is a universal-wound coil on a ½-inch-diameter

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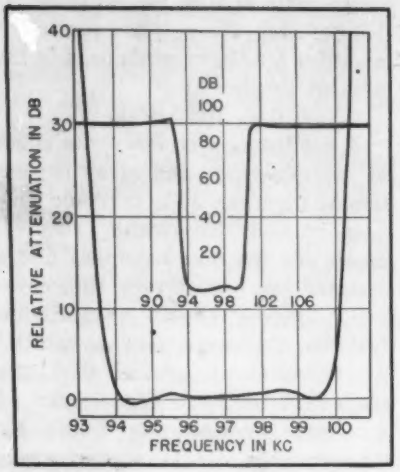

FIG. 14—Attenuation characteristic of a four-section crystal channel filter for 94-99.9 kc

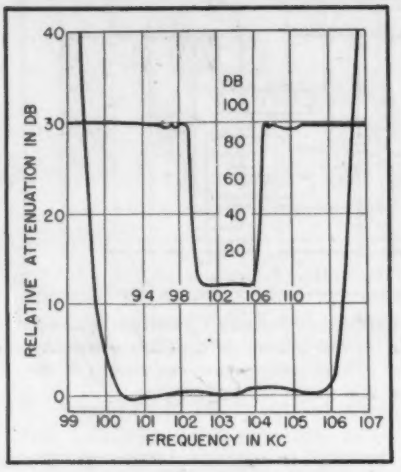

FIG. 15—Attenuation characteristic of a four-section crystal channel filter for 100.1-106 kc

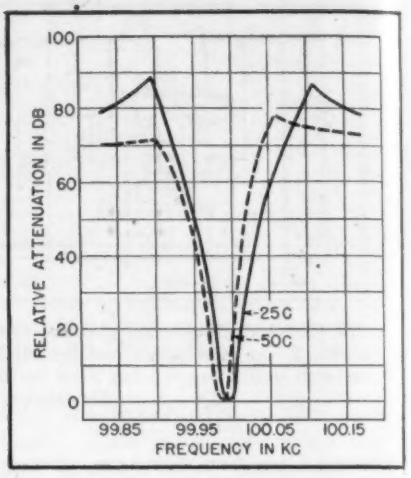

FIG. 16—Attenuation-frequency characteristic and effect of temperature change on the 100-kc 2-section carrier filter

Isolantite form. The coil is equipped with an adjustable powdered-iron core, and in use is mounted in the shielding can.

Construction of Carrier Filter

The narrow-band filter for the 100-kc intermediate-frequency carrier was much simpler in design and construction than the channel filters described above.

Calculated values of the motional capacitance together with the chosen theoretical passband width of 40 cycles, and the chosen frequencies of the attenuation peaks, determined the value of image impedance.

Here, again, as for the 6-kc channel filters, terminating resistors of smaller size than the image impedance were used to give a better impedance match throughout the passband. Figure 13 is a schematic diagram of the wiring of this double-section narrow-band filter.

Each single section consists merely of two divided-plating crystals, two small mica capacitors and the terminating resistors. The three resistors (at the center of the under-chassis view) constitute a pi-type attenuation pad of about 7 db between the two sections. Input and output terminating resistors are mounted externally to the shield can.

Results and Conclusions

Each of the two complete four-section 6-kc channel filters had an insertion loss within the passband itself of about 24 db. To compensate for this loss, the filter was fed from and into vacuum-tube circuits. The tube supplying the signal to the input of the filter was a 6J5 used in a cathode-follower circuit for easy impedance matching. The output of the filter was fed to a 6SK7 pentode amplifer. The result was a gain within the passband of 1.5 db measured from input to cathode follower to output of the pentode amplifier. The same type of tube-circuit arrangement was used with the carrier filter.

The attenuation characteristics of the lower and upper channel four-section crystal filters are shown in Fig. 14 and 15. The average characteristics are as follows:

Width of passband between points 2 db down, 5.94 kc; 2-db point adjacent to carrier, 134 cycles from carrier, passband flat within ±0.6 db over a bandwidth of 5.73 kc; bandwidth at 85 db down, 8.10 kc; attenuation greater than 87 db for all frequencies separated more than 4.17 kc from the passband midfrequency. Tests of the 6-kc channel filters at 25C and 50C respectively show a slight narrowing of the passband with rise in temperature averaging about two-and-one-half cycles per centigrade degree of temperature change. This is shown in Table I.

In Fig. 16 are shown two passband and attenuation characteristics of the double-section carrier filter. These were measured respectively at 25C and 50C. A rise of temperature is observed to cause the characteristic as a whole to shift to slightly lower frequencies. The shift averages only 0.44 cycles per deg. The bandwidth of the filter characteristic measured at room temperature is 16 cycles at a relative attenuation of 3 db, 22 cycles at 6 db, 86 cycles at 50 db and 180 cycles at 78 db. The latter attenuation is maintained for all frequencies outside the 180-cycle band mentioned.

The author desires to express his appreciation for helpful guidance, valuable suggestions, and continued interest to E. D. Blodgett, Thomas Jacobi and L. L. Lakatos of the Engineering Products Department of the RCA Victor Division. He is also thankful to the staff of the RCA Crystal Engineering Department for preparation and mounting of the crystals, and to the RCA-Victor Division of the Radio Corporation of America at Camden, New Jersey, whose facilities made possible the development herein described.

References

(1) W. P. Mason, "Electromechanical Transducers and Wave Filters," Chap. VIII, D. Van Nostrand Co., Inc., 1942.
(2) E. A. Guillemin, "Communication Networks," Vol. II, Chap. VIII, Art. 6; Chap. X, Art 2, John Wiley and Sons, 1935.
(3) J. B. Atwood, The Equivalent Electrical Circuit of Quartz Crystals, RCAC Eng. Report F-72-7, 1/19/39, Sheets 6, 12, and 15.
(4) R. A. Heising, "Quartz Crystal Applications," p 538, D. Van Nostrand Co., Inc., 1946.
(5) W. P. Mason, Electrical Wave Filters Employing Quartz Crystals as Elements, *B.S.T.J.* 133, p 410, July 1934.

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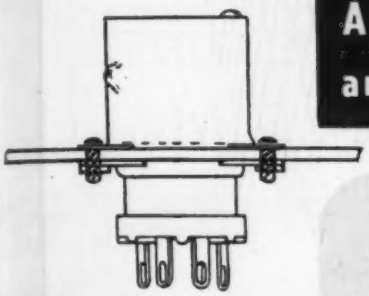

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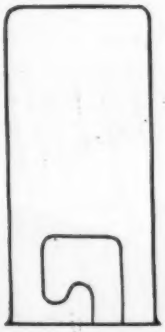

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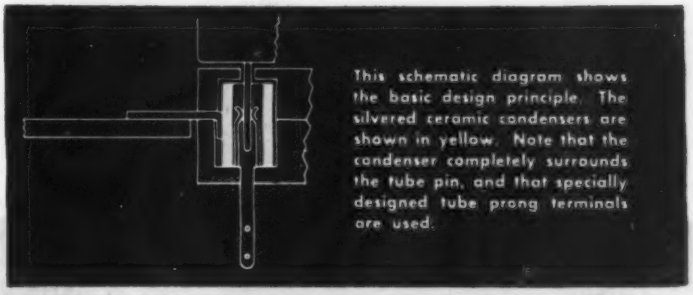

This schematic diagram shows the basic design principle. The silvered ceramic condensers are shown in yellow. Note that the condenser completely surrounds the tube pin, and that specially designed tube prong terminals are used.

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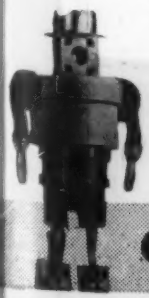

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Tele Service Areas

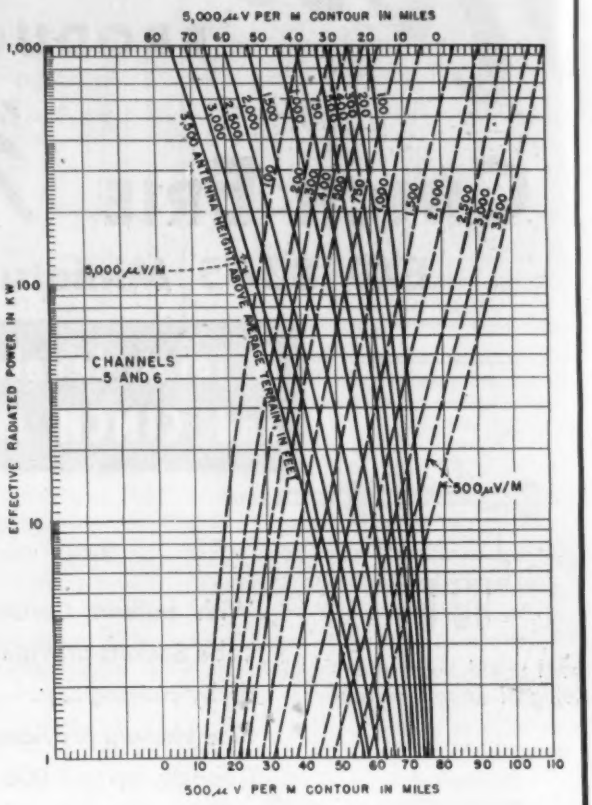
By JOHN H. BATTISON

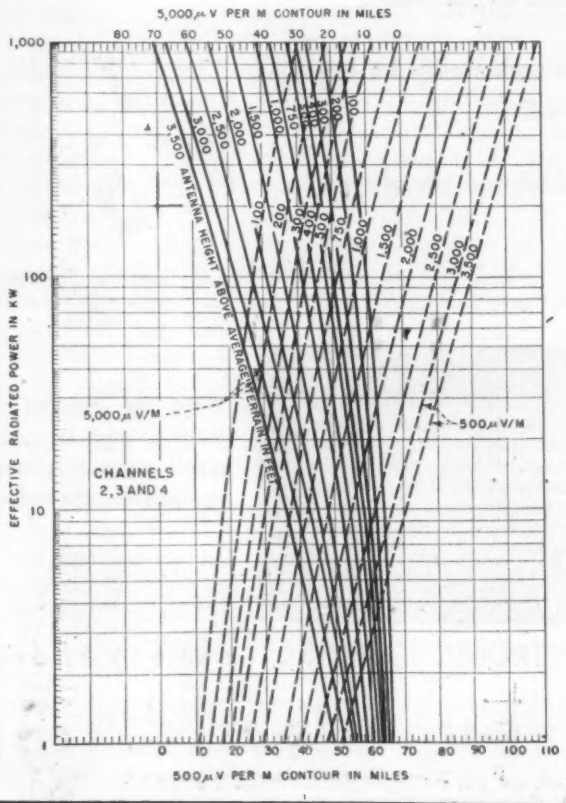
Allocations Engineer
American Broadcasting Co., Inc.
New York, N. Y.

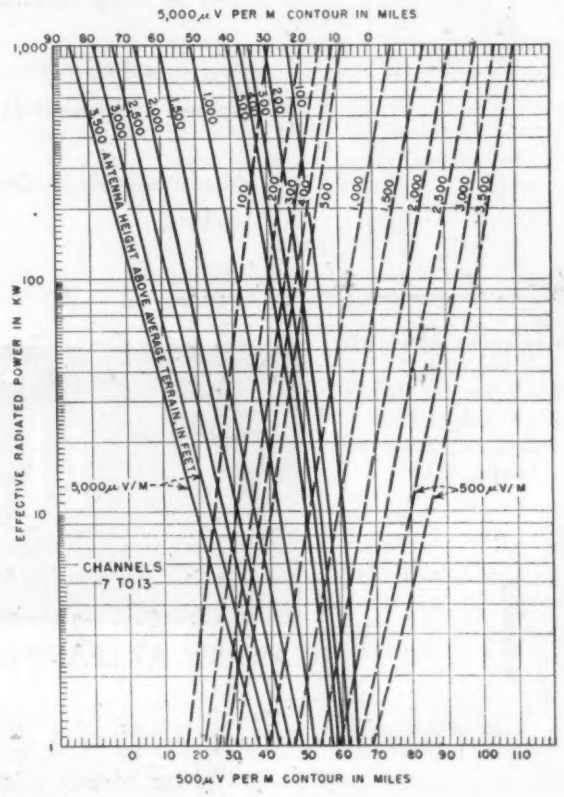
THE accompanying charts, based upon FCC assumptions and data, provide a quick approximation of television service areas for the 5,000 μv per meter (solid line) and 500 μv per meter (dashed line) contours. Receiving antenna height is assumed to be 30 feet above average terrain.

To determine the distance from a channel 2 20-kw transmitter 2,000 feet above average terrain to the 5,000 μv per meter contour, enter the appropriate chart at the left and follow the effective radiated power line across to its junction with the solid curve for 2,000 feet. Then read off the distance in miles (29 miles, in this case) from the scale at the top of the graph. The 500 μv contour from a similar transmitter would be found at 60 miles, using the dashed line for height and the lower scale of miles.

Power and antenna height necessary for desired coverage can also be determined from the charts.


5,000 μ V PER M CONTOUR IN MILES
80 70 60 50 40 30 20 10 0
1,000
100
10
1
EFFECTIVE RADIATED POWER IN KW
3,500 ANTENNA HEIGHT ABOVE AVERAGE TERRAIN IN FEET
5,000 μ V/M
500 μ V/M
CHANNELS 5 AND 6
0 10 20 30 40 50 60 70 80 90 100 110
500 μ V PER M CONTOUR IN MILES


5,000 μ V PER M CONTOUR IN MILES
80 70 60 50 40 30 20 10 0
1,000
100
10
1
EFFECTIVE RADIATED POWER IN KW
3,500 ANTENNA HEIGHT ABOVE AVERAGE TERRAIN IN FEET
5,000 μ V/M
500 μ V/M
CHANNELS 2, 3 AND 4
0 10 20 30 40 50 60 70 80 90 100 110
500 μ V PER M CONTOUR IN MILES


5,000 μ V PER M CONTOUR IN MILES
90 80 70 60 50 40 30 20 10 0
1,000
100
10
1
EFFECTIVE RADIATED POWER IN KW
3,500 ANTENNA HEIGHT ABOVE AVERAGE TERRAIN IN FEET
5,000 μ V/M
500 μ V/M
CHANNELS 7 TO 13
0 10 20 30 40 50 60 70 80 90 100 110
500 μ V PER M CONTOUR IN MILES

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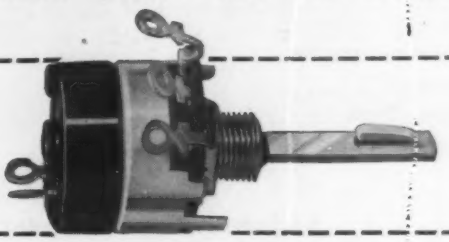

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Airborne Magnetometer

MEASUREMENTS accurate to one part in 50,000 of the earth's magnetic field are made with the airborne magnetometer developed by the Gulf Research and Development Co. engineers and geologists and recently demonstrated at Westchester County airport. The instrument is currently being used in prospecting for oil and mineral deposits. The odds of finding oil have been improved from approximately 16:1 to 5:1 by the use of such reconnaissance tools as airborne magnetometers, gravimeters and seismographs. Novel magnetic and circuit techniques are used in the magnetometer to obtain its high sensitivity.

Operating Principle

Geologists have used the correlation between the magnetic field of the earth at its surface and the underground rock formations for many years. For these measurements on the ground, a delicately balanced instrument was used, but to survey large or rugged areas took a great deal of time and effort.

Several difficulties arise if a conventional magnetometer is used in an aircraft. Accelerations of the instrument must be counteracted. This requirement limits the design to one having no moving parts. Because of the speed of motion, the instrument must be automatically recording; an operator could not take readings fast enough in a plane flying at 120 mph. The magnetic fluctuations to be measured are so slight that they could be masked by unbalanced magnets and currents, so the instrument must be suspended a considerable distance from the mother plane.

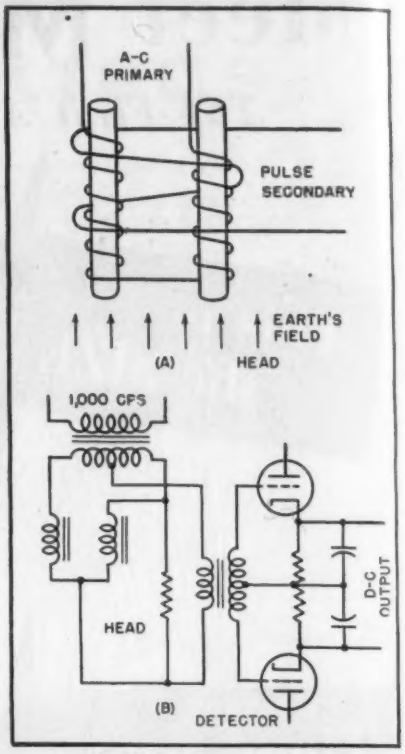
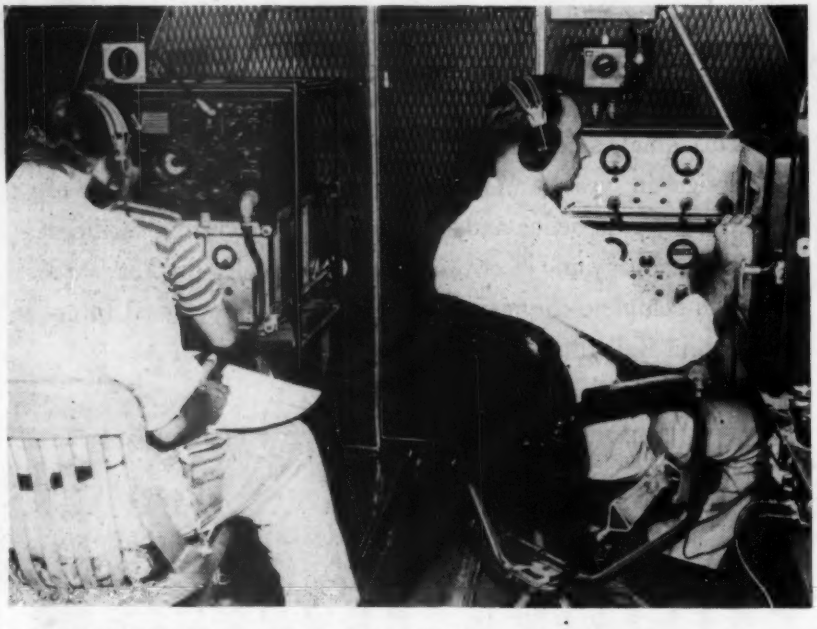


FIG. 1—Magnetometer head depends for its action on the change in inductance as the core becomes saturated (A). The pulses produced by the head are converted to direct current and combined to give a signal proportional to the magetic field

To meet these requirements, a sensing element of the flux-gate type was developed, and by 1941 had been perfected sufficiently for airborne use. During the war the instrument was used for locating submerged submarines, for which application it needed to be sensitive only to short, intense discontinuities in magnetic field. It has been further refined to give an absolute indication and to hold its calibration.

Basically the sensing element consists of two thin cores of highly permeable alloy on which are wound two separate coils as shown in Fig. 1A. The sensitivity of the element is obtained by exciting these identical coils with alternating current (1,000 cps).

As long as the impedances presented by both coils are equal, the voltages across the two primaries will be equal, whether the cores are saturated or not, because both cores will become saturated simultaneously, although with opposite polarities. However, if the element is placed in a fixed magnetic field, the



In flight, the magnetometer operator at the right makes notations on the magnetic record of information provided by the sensing unit. At left, an operator checks the shoran pulses while the flight director corrects the course flown and advises the pilot

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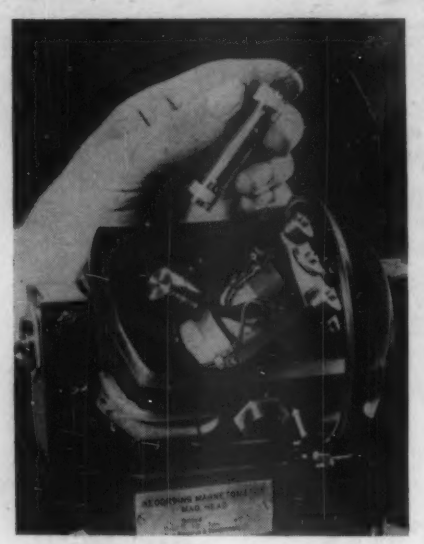

Sensing element of the airborne magnetometer and the gimbal mounting for positioning the unit parallel to the earth's magnetic field

two cores will become magnetically biased so that one will enter saturation in the direction of the external field before the other enters saturation in the opposite direction. Thus there will be a moment when the two coils do not present equal impedances.

A short voltage pulse will occur across a secondary winding (or its electrical equivalent) because of the phase shift of the moment of passing the knees of the magnetization curves of the two cores. For small external fields, the amplitude of this pulse is proportional to the field strength (The Gulf Airborne Magnetometer, R. D. Wyckoff, Geophysics, p 182, April, 1948).

Auxiliary Circuits

To use such an element in an airplane requires several auxiliary circuits. Figure 1B shows the detector circuit with which the pulses are picked off the sensing element by a differential transformer and converted to direct current by cathode followers. By design of the sensing circuit and coupling transformer, sufficient voltage is obtained at the input to the differential cathode-follower circuit so that no subsequent amplification is necessary.

Because of the permeability of the cores of the magnetometer head, the unit is saturated by relatively weak fields. To prevent saturation and also to provide a range

(continued on p 140)

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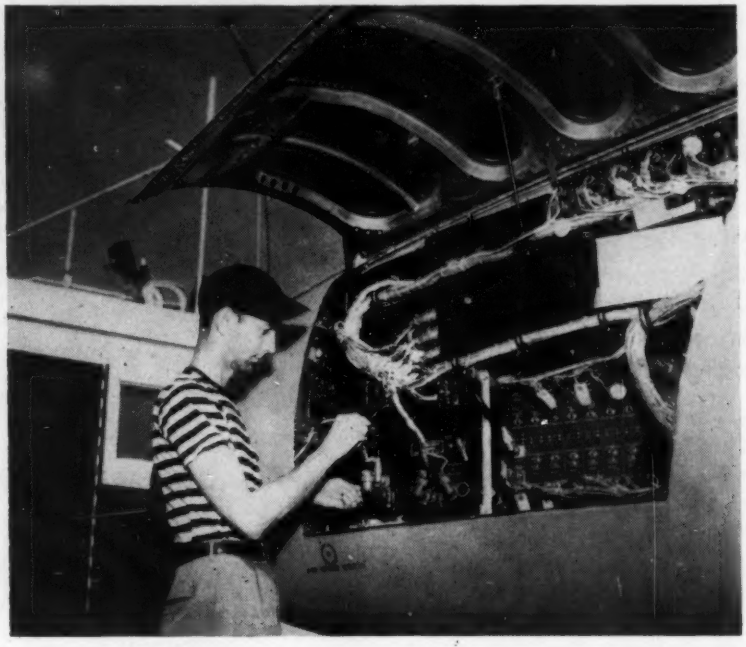
Space normally occupied by the engine in conventional ships contains, in this case, about three times as much equipment as that visible in the accompanying photograph. It includes an f-m transmitter and receiver, telemetering and television equipment.

A television camera monitors an instrument panel set up in the forward portion of the nose. The panel contains the attitude gyro, airspeed indicator, altimeter, tachometer, magnetic compass, accelerometer, elevator trim tab position, correlating counter, dive flap down light and fire warning light.

Four motion picture cameras in the plane are started and stopped by remote control. One is in the cockpit to photograph the regular instrument panel, one alongside the television camera in the nose and two mounted in the fuselage to photograph either wing tip.

The correlating counter on the instrument panel in the nose is used, along with pips entered at intervals directly on movie film in each camera, to correlate all movies with the plane's actions at a given moment and also with a fifth camera photographing the television receiver screen in the truck. By use of television, the plane can be flown by remote control from inside the truck, except for take-off and landing.

Pictured testing the electronic equipment is civilian radio-control engineer Richard W. Hill, of the instrumentation section of the Flight Test Division at Air Materiel Command headquarters, Wright-Patterson Air Force Base, Ohio. U. S. Air Force photo by CWO Stephen P. Mongelluzzo.



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THE ELECTRON ART

Edited by FRANK ROCKETT

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Magnetic Field Patterns Shown by Electron Microscope

EXTENSION of the experimental method adapted at the National Bureau of Standards for visually studying magnetic fields provides a powerful means for investigating space-charge fields, fields produced by contact potentials, configurations inside waveguides, and the microstructure of metals. The method, developed by L. L. Marton, is the electronoptical analogy of the Schlieren effect in optics. By it, static magnetic and electric fields can be examined without the disturbing effects of probes; it is being used to measure the magnetization of wire used for sound recording and for storing data to be used by electronic computers.

Dark-Field Image

Figure 1A shows an image produced by the modified electron microscope used in the quantitative study of magnetic fields. The electronoptical arrangement by which this image is produced is shown in Fig. 1B. Electrons from source *A* are normally brought to a focus by lens *C* at point *D*. However, if there is a disturbing field at *B* such as a magnetized wire, it will distort the electron trajectories so that a dark image of the obstruction will be formed on screen *E* placed in the conjugate plane. The lens will also bring to focus on this plane an image of the disturbing field. A stop intercepts the undisturbed electrons focused at *D*. The dark-field image at *E* is made visible by a fluorescent screen or is recorded as a micrograph. Figure 1C is an approximate picturization of the action involved.

Figure 2 shows the image produced when a presaturated thin laminar steel sample with a feather edge is placed in the electron microscope between the source and the lens. The objective lens was slightly misaligned in making this picture to bring one edge of the objective parallel to the observed edge. In this way the direct rays were intercepted by the objective aperture, only the electrons scattered at the edge of the specimen reaching the final image plane to form the image. The faint pattern at right angles to the edge of the bright line, visible wherever the line is interrupted, is assumed to be due to the fringe field of ferromagnetic domains or of grain boundaries. In this way a visual representation of fringe fields from the small domains of spontaneous magnetization in ferromagnetic materials is

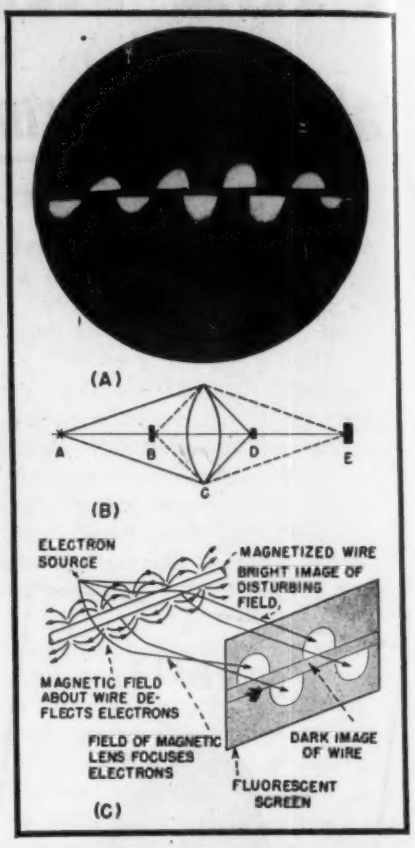


FIG. 1—(A) Opposite polarities of adjacent magnetized regions on both sides of a wire deflect electrons of microscope to produce bright semicircles on a fluorescent viewing screen. The optical system (B) intercepts direct rays unaffected by field of wire as shown by solid lines; dashed lines show how field of wire is focused on screen by same lens. An approximate perspective drawing (C) shows paths of deflected electrons. This electron analogy of the optical Schlieren effect adds another type of object, namely fields, that can be observed in electron microscopes

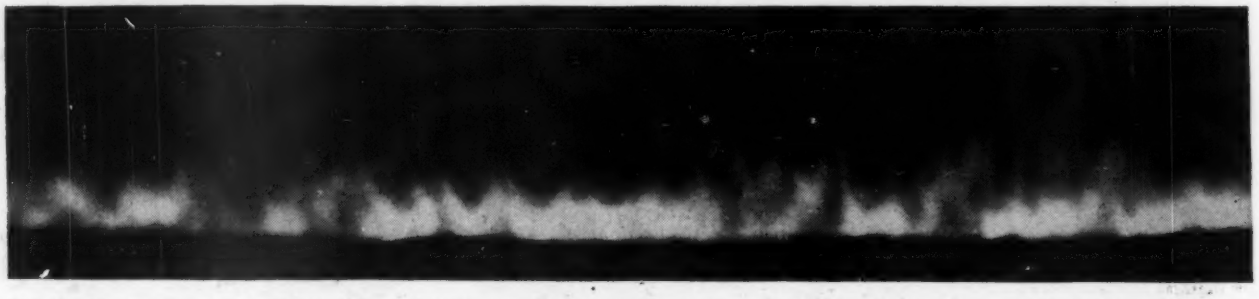
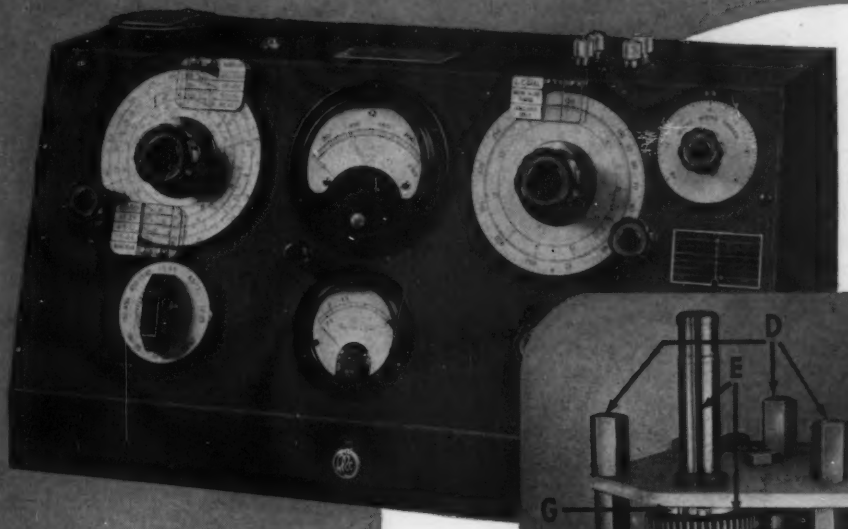
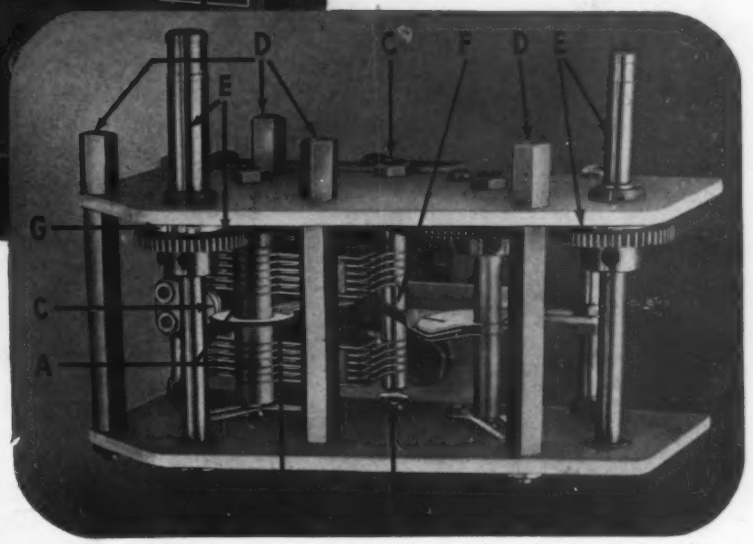


FIG. 2—Micrograph made with modified electron microscope of the fringe field along the edge of a steel sheet indicates that magnetic domains or grain boundaries are a few microns apart (magnification about 50,000 diameters)

For the MEASUREMENT of
Q, INDUCTANCE and CAPACITANCE





The 160-A Q-METER
50 KC. to 75 MC.

Radio frequency circuit design often requires the accurate measurement of Q, inductance, and capacitance values. For this application, the 160-A Q-Meter has become the universal choice of radio and electronic engineers throughout the country.

Each component part and assembly used in the manufacture of this instrument is designed with the utmost care and exactness. Circuit tolerances are held to values attainable only in custom built instruments.

Consider, for example, the Q tuning capacitor assembly of the 160-A Q-Meter, specially manufactured for maximum range, low loss, and minimum residual inductance. The ultimate design of this unit was reached only after months of intensive engineering research to produce the finest in performance, quality, and workmanship.

This is but one of the many desirable features of the 160-A Q-Meter which contribute to its outstanding accuracy and dependability.

Be sure to include the 160-A Q-Meter in your new equipment plans for 1948.

Write for Catalog "E"

Shown above is the Q tuning capacitator assembly of the 160-A Q-Meter. Note the following design features of this unit—features which insure reliable, trouble-free operation.

A. Parallel connection of dual rotor and stator assemblies minimizes internal inductance and resistance.
B. Spring silver fingers contact both sides of silver disc to provide low series resistance.
C. Three point pyrex ball stator suspension reduces losses and permits accurate stator alignment.
D. Four point panel mounting designed to produce maximum structural rigidity and capacitance stability.
E. Precision-cut brass spur gears and stainless steel shafts, mounted in oversize bearings, assure long, trouble-free service.
F. Common stator mounting for main and vernier stator plates reduces loss and internal series resistance of vernier capacitor section.
G. Positive shaft stop protects main rotor assembly and gears against mechanical overload.

SPECIFICATIONS

Oscillator Frequency Range: 50 kc. to 75 mc. in 8 ranges.
Oscillator Frequency Accuracy: ±1%, 50 kc.—50 mc.
±3%, 50 mc.—75 mc.

Q Measurement Range: Directly calibrated in Q, 20-250. "Multiply—Q—By" Meter calibrated at intervals from x1 to x2, and also at x2.5, extending Q range to 625.

Q Measurement Accuracy: Approximately 5% for direct reading measurement, for frequencies up to 30 mc. Accuracy less at higher frequencies.

Capacitance Calibration Range: Main capacitor section 30-450 mmf, accuracy 1% or 1 mmf whichever is greater. Vernier capacitor section +3 mmf, zero,—3 mmf, calibrated in 0.1 mmf steps. Accuracy ±0.1 mmf.

BOONTON RADIO Corporation
BOONTON · N·J·U·S·A

DESIGNERS AND MANUFACTURERS OF THE Q METER · QX CHECKER · FREQUENCY MODULATED SIGNAL GENERATOR · BEAT FREQUENCY GENERATOR AND OTHER DIRECT READING INSTRUMENTS

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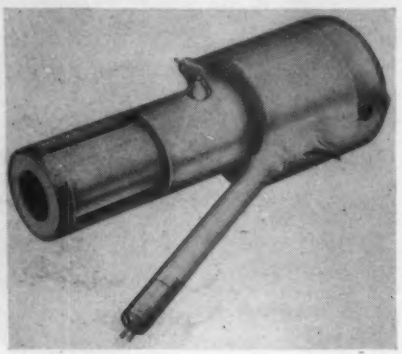
obtained from which the field distribution and domain sizes can be computed.

The Eriscope Camera Tube

By Boyd France
McGraw-Hill World News
Paris, France

HIGH RESOLUTION AND SENSITIVITY are obtained in the French television camera tube called the eriscope. Like the image orthicon, this tube separates the functions of forming and scanning the image.

Comparative tests of the eriscope and the image orthicon conducted at the Zurich Polytechnical School



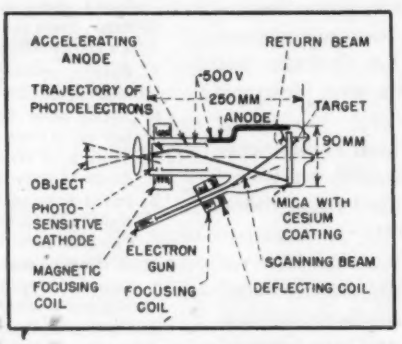
Like image orthicon, formation of electrical image and scanning are separate operation in eriscope; signal is amplified externally

indicated that the eriscope had the greater resolution; it produced sharper images with greater tonal range and haltfone definition and less spotting. All tubes now coming from the production line of the Society Radio Industrie de France have a definition of 800 lines, some are capable of 1,000 lines. All these tubes being made currently are for the state television company. The tests also showed that the image orthicon is the more sensitive. For picking up outdoor scenes with the eriscope, 100 lux is sufficient. Under artifical light it is necessary to increase the illumination to 500 lux because the tube is less sensitive to red than to blue light.

Forming and Scanning the Image

By separating the functions of converting light images into electrical ones and of scanning the electrical images, the elements of the camera tube can be designed independently for maximum efficiency. The transparent photosensitive cathode, whose position is shown in the accompanying diagram, is an alloy of cesium and antimony. The optical image is formed on the interior surface of this cathode thus emitting electrons in proportion to the incident photons. These electrons are accelerated by an anode at 500 volts above the photocathode, the two electrodes forming a divergent lens for the electrons. A magnetic focusing coil gives the electrons a trajectory such as that shown in the diagram.

In this way the optical image has been converted into an electrical image, which in turn has been focused on the scanning target at the far end of the tube. The target is a semiconductor made of a sheet of mica coated thinly with metallic cesium. The electrons from the photocathode form an electrical image on this target corresponding to the optical image. The target is then scanned by a beam of electrons from an electron gun in the arm of the tube. This beam is magnetically focused to a spot whose size determines the resolution of the tube, and is magnetically scanned



Because image target has no mosaic, resolution is only limited theoretically by focus of scanning beam

over the image on the target. With a beam 0.10 millimeter in diameter it is possible to obtain a definition of 400 lines using an 80 square millimeter target. Higher resolutions are obtained by finer focusing.

The beam is charged to the same potential as the target. As it reaches the target, electrons are deflected from it in proportion to the surface charge of the target. These deflected electrons are picked up by an anode on the surface of the tube producing the output signal, which is amplified externally. The undeflected portion of the beam momentarily erases the target image.

The Miller F-M Circuit and Its Use in Railroad Radios

By P. L. Bargellini
Florence, Italy

THE INCREASING DEVELOPMENT of communication systems using frequency or phase modulation has stimulated the invention of several forms of modulators. In practical use these modulators suffer from poor carrier stability or great complexity in their stabilizing circuits, and limited ranges of linearity. Because of inadequacies in the reactance-tube modulators being used in experiments with railroad radiophones, especially microphonics in the reactance tube, another type of frequency modulation circuit was devised.

Miller-Effect Modulator

Important properties of a frequency modulator are: (1) inertialess linear frequency controlling element, (2) simple production and injection of voltage for stabilizing carrier frequency, and (3) stability in the presence of mechanical vibration. Requirement (1) calls for an electronic modulating element of considerable simplicity. (The reactance tube suffers from the fact that it can never be a pure reactance, always having some residual resistance.) Requirement (2) is more simply satisfied if the frequency modulation is produced directly rather than indirectly as in some systems. A triode more adequately fills requirement (3) than a multigrid tube.

The means taken to meet these requirements is shown in Fig. 1A. By it, a pure reactance can be injected into the oscillatory circuit. The quadrature current is simply obtained from the grid-cathode space current of a triode that is excited by the controlled resonant L-C circuit and that has a purely resistive load. Analysis of the cir-

(continued on p 186)

achieving a new 'high' of efficiency!

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CERAMIC *Hi-Load* CAPACITORS

Designs registered U.S.A., U.K. and other territories.

for R.F. Heaters and Transmitters

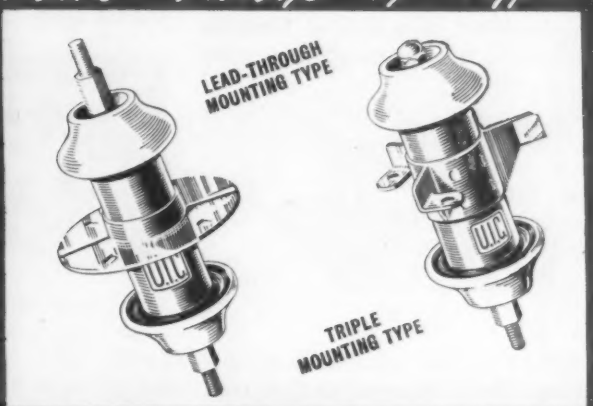
Special silver layer gives low-loss high conductivity electrode surfaces
Special ceramic body gives low losses under R.F. load
Tag electrode soldered to outside silver layer gives even current distribution
Glazed sheds give ample flash-over path in all conditions of humidity
Aero-dynamic shape gives improved cooling, particularly with forced draught
Heavy rod with double spider mounting gives reliable heavy current connection to inside silver layer
U.I.C.
TAG MOUNTING TYPE

U.I.C. of England, pioneers in the manufacture of Ceramic Transmitter Capacitors, are foremost in the application of aerodynamic principles to capacitor design. The new aerodynamic shape of U.I.C. "Hi-Load" Capacitors gives optimum cooling in still air. With forced draught their high R.F. ratings can be multiplied. All three types of mounting assist cooling and cater for a variety of applications, such as single stand-off tag fitting, parallel and series banking for very large powers, and lead-through types for anode by-pass.

Examples from a wide range of Types

Type	HLS2031	HLT2021	HLT2021	HLC2011	HLC2014*
Capacitance	125pF	300pF	600pF	800pF	1000pF
Max. R.F. Load	70KVA	50KVA	50KVA	25KVA	40KVA
Peak Voltage	7.5KV	7.5KV	7.5KV	7.5KV	7.5KV
Max. R. F. Current	30 Amps.	30 Amps.	30 Amps.	30 Amps.	30 Amps
Body Dimensions	1¼" x 3¼"	1¼" x 3¼"	1¼" x 3¼"	1¼" x 3¼"	1¼" x 3¼

* Lead-through type, all other examples tag type.



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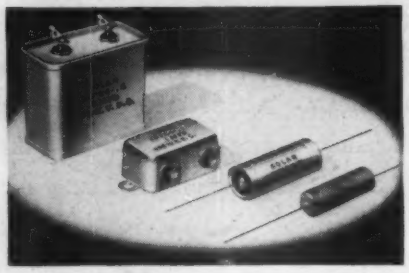
NEW PRODUCTS

Edited by A. A. McKENZIE

New equipment, components, tubes, testing apparatus and products closely allied to the electronics field. A review of catalogs, handbooks, technical bulletins and other manufacturers' literature

Polystyrene Capacitors

SOLAR MFG. CORP., 1445 Hudson Blvd., North Bergen, N. J., now has available a complete line of polystyrene-film dielectric capacitors. Typical applications include timing and integrating circuit capacitors, r-f padding capacitors



and coupling capacitors in extremely high-gain amplifiers. Complete list of standard ratings is given in catalog bulletin SPD-600.

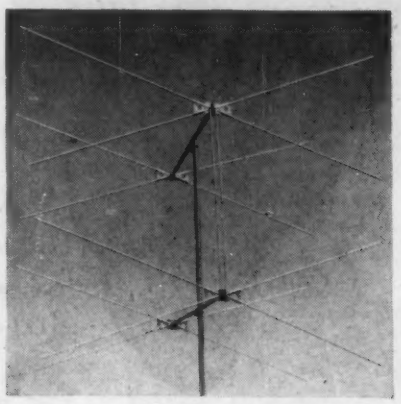
Klystrons

RADIO CORP. OF AMERICA, Harrison, N. J. First of a line of Klystron tubes for use in microwave relay

equipment are types 2K26 and 2K25. These tubes can be used both for transmission and reception, serving as local oscillator in the latter service.

Conical Antenna

TELREX INC., 26 Neptune Highway, Asbury Park, N. J. Model 4XTV an-



tenna gives conical performance without the bulk of solid spinnings. It features gain, bandwidth and resolution.

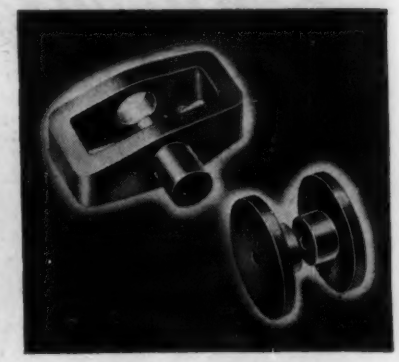
Impedance Meters

SPERRY GYROSCOPE CO., Great Neck, N. Y., announces a series of nine instruments for determining impedance by measuring standing wave ratios and node positions in microwave transmission lines.

They can also measure relative power, attenuation and wavelength in the line. Accuracy is 2 percent for 650 to 40,000 mc. Catalog sheets are available.

Molded Transformer Cores

STACKPOLE CARBON CO., St. Mary's Pa. Cores are available for horizontal deflection and flyback transformers. Two standard types



are available. Type 10034 is a large rectangular unit with sliding hub designed for universal use with any television tube. A smaller spool type 10748 is recommended for tubes smaller than 10 inches where space is at a premium.

F-M Tape Recorder

AMPEX ELECTRIC CORP., 125 Howard Ave., San Carlos, Calif. De-

signed expressly for f-m broadcast service, the new Ampex tape recorder has a response within plus or minus 1 db between 30 and 15,000 cycles as well as other features designed for broadcast facility. Tape speed is 30 inches per second and the unit has a time capacity of 35 minutes.

Keyboard Oscillator

WEINSCHEL ENGINEERING CO., Dept. E, 123 William St., New York 7, N. Y. This stable oscillator with low distortion is of the resistance-tuned type using negative feedback. Pushbuttons on the panel provide frequency variation. The unit

6 REASONS WHY 6,000,000* RAYTHEON SUBMINIATURE TUBES Are Working For American Industry Today

1. **REDUCED PRODUCT SIZE . . . INCREASED PRODUCT ACCEPTANCE.** Raytheon filamentary Subminiatures are flat. Batteries can be little instead of big because of extremely low filament drain.

2. **PLUG INTO STANDARD SOCKETS — OVER ONE AND ONE-HALF MILLION IN USE.** All Raytheon Subminiatures can either be soldered or welded into the circuit, or plugged into the sockets available from several manufacturers.

3. **NINE YEARS CONTINUOUS PRODUCTION EXPERIENCE.** Total customer returns of defective tubes in 1947 just under 1% of sales.

4. **SUBMINIATURE TUBE APPLICATION ENGINEERING** available nationally since 1939.

5. **READILY AVAILABLE FROM STOCK IN NEWTON, CHICAGO AND LOS ANGELES.** Over half a million of the tubes described below are available at all times. They are standard throughout the world.

6. **AT YOUR LOCAL DISTRIBUTOR:** Over three hundred Raytheon Special Purpose Tube distributors stand ready to serve you quickly and intelligently.

*More than all other makes combined!

Characteristics of Representative RAYTHEON Subminiature Tubes

Type No.	Remarks	Maximum Diameter Inches	Maximum Length Inches	Filament Or Heater Volts	Filament Or Heater Ma.	Mutual Conductance Umhos	Power Output MW	TYPICAL OPERATING CONDITIONS Plate Volts	Plate Ma.	Screen Volts	Screen Ma.	Grid Volts
HEATER CATHODE TYPES												
CK5702/CK605CX	Characteristics of 6AK5	0.400	1.5	6.3	200	5000		120	7.5	120	2.5	-2.0
CK5703/CK608CX	Triode UHF Oscillator, ¾ watts at 500 Mc	0.400	1.5	6.3	200	5000		120	9.0			-2.0
CK5704/CK606BX	Diode, equivalent to one-half 6AL5	0.315	1.5	6.3	150			150ac	9.0			
CK5744/CK619CX	Triode High mu.	0.400	1.5	6.3	200	4000		250	4.0			-2.0
CK624CX	Characteristics of 6AS6	0.400	1.5	6.3	200	3200		120	5.2	120	3.5	-2.0
FILAMENT TYPES												
2E31-32	RF Pentode for pocket radio	0.300x0.400	1.56	1.25	50	500		22.5	0.4	22.5	0.3	0
2E35-36	Output Pentode for pocket radio	0.290x0.390	1.56	1.25	30	385	1.2	22.5	0.27	22.5	0.07	0
2E41-42	Diode Pentode for pocket radio	0.290x0.390	1.56	1.25	30	375		22.5	0.35	22.5	0.12	0
2G21-22	Triode Heptode for pocket radio	0.300x0.400	1.56	1.25	50	75 conv. cond.		22.5	0.20	22.5	0.30	
RK61	Gas Triode, Exp. Radio Control	0.550	1.81	1.4	50			45.0	1.5	Special Circuit		
CK502AX	Output Pentode	0.285x0.385	1.5	1.25	30	550	6.0	45.0	0.6	45.0	0.15	-1.25
CK503AX	Output Pentode	0.285x0.385	1.5	1.25	30	550	9.5	45.0	0.8	45.0	0.25	-2.0
CK505AX	Voltage Amp. Pent.	0.285x0.385	1.5	0.625	30	38†		22.5	0.125	22.5	0.04	-0.625
CK506AX	Output Pentode	0.285x0.385	1.5	1.25	50		25.0	45.0	1.25	45.0	0.40	-4.5
CK510AX	Double Space Charge Tetrode Amplifier	0.285x0.410	1.25	0.625	50	150† both units		45.0	0.06			0
CK512AX	Low microphonic voltage amplifier	0.285x0.385	1.25	0.625	20	37†		22.5	0.125	22.5	0.04	-0.625
CK522AX	Output Pentode 20 ma. filament	0.285x0.385	1.5	1.25	20	430	1.2	22.5	0.30	22.5	0.08	0
CK523AX	Output Pentode	0.285x0.385	1.5	1.25	30	360	2.5	22.5	0.30	22.5	0.075	-1.2
CK524AX	Output Pentode	0.285x0.385	1.5	1.25	30	300	2.2	15.0	0.45	15.0	0.125	-1.75
CK525AX	Output Pentode	0.285x0.385	1.5	1.25	20	325	2.2	22.5	0.25	22.5	0.06	-1.2
CK526AX	Output Pentode	0.285x0.385	1.5	1.25	20	400	3.75	22.5	0.45	22.5	0.12	-1.5
CK527AX	Output Pentode 15 ma filament	0.285x0.385	1.5	1.25	15	225	0.75	22.5	0.10	22.5	0.025	0
CK529AX	Shielded Output Pentode	0.290x0.390	1.5	1.25	20	275	1.2	15.0	0.20	15.0	0.05	-1.5
CK551AXA	Diode Pentode	0.300x0.400	1.56	1.25	30	235		22.5	0.17	22.5	0.043	0
CK553AXA	RF Pentode	0.300x0.400	1.56	1.25	50	550		22.5	0.42	22.5	0.13	0
CK5672	Output Pentode	0.285x0.385	1.5	1.25	50	625	60.0	67.5	2.75	67.5	1.0	-6.25
CK5676/CK556AX	Triode, UHF Oscillator for radio use	0.300x0.400	1.5	1.25	120	1600		135.0	4.0			-5.0
CK5677/CK568AX	Triode, UHF Oscillator for radio use	0.300x0.400	1.5	1.25	60	650		135.0	1.9			-6.0
CK5678/CK569AX	RF Pentode	0.300x0.400	1.5	1.25	50	1100		67.5	1.8	67.5	0.48	0
CK5697/CK570AX	Electrometer Triode Max. grid current 5×10^{-13} amps.	0.285x0.410	1.25	0.625	20	1.5†		12	0.22			-3.0
CK571AX	10 ma. filament electrometer tube, $Ig=2\times10^{-13}$ amps.	0.285x0.410	1.5	1.25	10	1.6†		10.5	0.20			-3.0

†Voltage Gain (times)

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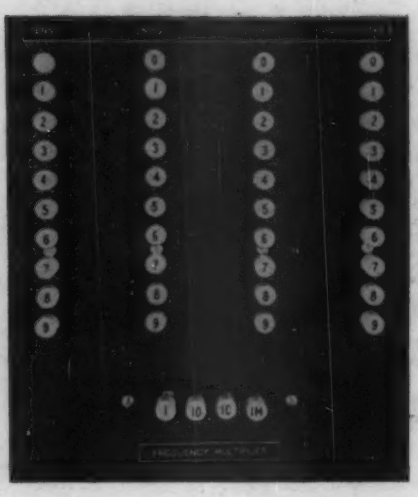


can be used as a signal source for distortion or bridge measurements, and also as an interpolation oscillator. Frequency range is from 1 cycle to 100 kc.

Capacitance Bridge

GENERAL RADIO Co., 275 Massachusetts Ave., Cambridge 39, Mass. Type 1611-A capacitance test bridge measures over the range 1 μμf to 10,000 μf. Accuracy of ± (1 percent + 1 μμf). Dissipation factor range is 0 to 60 percent. Frequency

of the test voltage is 60 cycles. A feature of the bridge is the zero-compensating circuit that balances out the initial capacitance and dissipation factor at zero setting of the dials.

Variable Waveform Generator

CENTRO RESEARCH LABORATORIES, Briarcliff, N. Y. The variable waveform generator is an audio generator whose output waveform is built up by addition of a fundamental wave and four sequential harmonics. The harmonics are precisely synchronized and variable over 360 degrees. Level of the fundamental and of each of the harmonics is independently variable.

Rodent Control

LFC CORP., 65 Broad St., Rochester 4, N. Y. The Guard consists of a metal case housing a framework that supports electronic unit, motor for driving the electrocuting arms, mirrors for the light system, and other components. In action, the unit is placed over a rat run and is actuated by breaking of a light beam by a passing animal. It is

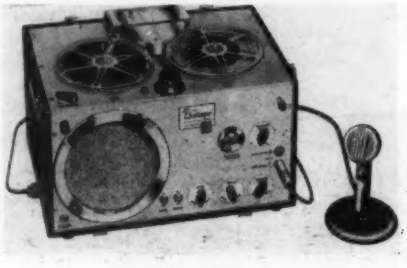
gently squeezed, electrocuted, and ejected to the side. Total death cycle is about 2½ minutes.

Visual Alignment Generator

PHILCO CORP., Philadelphia, Pa., Model 7008 is a new visual alignment generator equipped with crystal-diode high-frequency probe for use in examining the response curve of individual stages and the 4.5 mc video trap. It can also be used to obtain correct termination of r-f transmission lines or measure standing wave ratio.

Portable Tape Recorder

WEBSTER ELECTRIC Co., Racine, Wisconsin. The Ekotape recorder and reproducer uses magnetic tape with a fast forward speed and fast rewind. It is equipped with an 8-inch speaker and an oversize motor with high inertia flywheel. Motor drive and capstan operate continuously so that tape starts and stops instantaneously.



Electronic Thermostat

SPENCER-KENNEDY LABS., INC., 10 Follen St., Cambridge, Mass. Model 400A bridge-controlled thyratron thermostat is designed for use with furnaces, molds, chemical baths, ovens, and similar devices. Two types of control are possible, by means of a resistance thermometer,

or by change of resistance of the heater winding itself. Temperatures from 20 to 1,200 C can be maintained to an accuracy of plus or minus 0.1 C when a resistance thermometer is used.

Projection System

RADIO CORP. OF AMERICA, Camden, N. J. Model TLS-86 is a reflective optical projection system employing an all-electronic tuning system.

Life-size pictures for large audiences are then projected either on a reflective-surfaced opaque screen or on a translucent screen.

Television Signals

TELEQUIP RADIO Co., 1901 South Washtenaw Ave., Chicago 8, Ill. A combination sync generator, mono-

(Continued on p 206)

PRICES AND AUDIODISCS

A Statement On Our Price Policy

As of September 1st, aluminum prices are again increased. This means higher cost for the principal raw material used in the manufacture of AUDIODISCS. In fact, the cost of the aluminum base has always been the main item in the cost of production. Thus, any increase in aluminum prices is of major importance.

But beyond the cost of raw materials and labor there is a basic factor which determines the cost of manufacturing professional recording discs. This factor is the extent to which the particular process of manufacture enables the producer to turn out a large proportion of first quality discs. There are several methods of production used. None of these will give anything like a 100% yield. It is, however, obvious that as the percentage of yield increases there is a resulting drop in the average cost of aluminum, lacquer and labor.

Fortunately, our patented, precision-machine process—now used for over a decade and continuously improved—gives a more consistent yield of high quality discs than any method of production now used. And we have tested every other process in use.

So our position with respect to the present increase in aluminum prices is this:

1. We are *not* increasing prices of AUDIODISCS as of September 1st.

2. We shall make every effort to absorb this new aluminum price raise and thus continue our prices at the present level. Our calculations indicate that with some improved efficiency, now under way, and continued large volume production, we shall be successful in this hold-the-price effort.

Audiodiscs are manufactured in the U.S.A. under exclusive license from PYRAL, S.A.R.L., Paris.

Audio Devices, Inc., 444 Madison Ave., N.Y.C.

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NEWS OF THE INDUSTRY

Edited by JOHN MARKUS

Australia's rural radiophone; course in automatic control; radio net for India planned; radio license increase

West Coast IRE Convention

THE PROGRAM of technical sessions of the IRE West Coast Convention to be held September 30 to October 2, 1948, at the Hotel Biltmore, Los Angeles, Calif., has been announced as follows:

Thursday, Sept. 30

1:00 P.M. to 4:45 P.M.—Chairman—Bernard Walley of RCA Victor, Los Angeles:

A Low Cost Program Switching System, by I. Gifford and A. P. Chesney of Langevin.

Antenna Input Systems for Television Receivers, by D. E. Foster of Hazeltine Research, Inc., California.

Operation of AM Broadcast Transmitters into Sharply Tuned Antenna Systems, by W. H. Doherty of Bell Telephone Laboratories, Whippany, N. J.

1:15 P.M. to 4:45 P.M.—Chairman—A. R. Willson of Boeing Aircraft Company, Seattle:

The Outlook for Electronic Computers, by J. L. Barnes of the University of California at Los Angeles.

Input and Output Equipment for Electronic Computers, by C. H. Page of the Bureau of Standards.

Electronic Techniques Applied to Analog Methods of Computation, by D. G. McCann, C. H. Wilts, and B. M. Locanthi.

Design and Use of the Reevac, a General Purpose Electronic Digital Computer; by Dr. Herbert Zagor of Reeves Instrument Corporation, New York City.

8:00 P.M. to 10:30 P.M.—Audio Symposium — Chairman — E. S. Naschke, Chairman Sacramento Section IRE.

Friday, Oct. 1

9:00 A.M. to 11:40 A.M.—Chairman—O. A. Steele, Chairman Portland Section IRE:

A New Type of Direct Reading R. F. Phase Meter for Low [illegible] Signals, by M. K. Goldstein of Na[illegible]earch Laboratory.

The Determination of [illegible] Shunt Resistance of Cavity Resona[illegible] by Means of an Electrical Network [illegible]alyzer, by F. W. Schott and K. R. [illegible]genberg of Stanford University.

A Method of Obtaining [illegible] Product of Two Voltages, by M.A.H. E[illegible] Said. Paper presented by D. E. Sinclair of General Radio.

Propagation Measurements at High Radio Frequencies over Flat Desert Terrain, by J. P. Day and L. C. Trolese of Naval Electronics Laboratory.

2:30 P.M. to 5:15 P.M.—Chairman—L. E. Reukema of University of California,

Final details for [illegible]IRE Conve[illegible]tion are discussed [illegible]Howard (left) president of Triad [illegible]ice[illegible]er and West Coast Electronics Mc[illegible]gers president. Robert L. Sink (stand[illegible] Consolidated Engineering, and Conv[illegible]on chairman Loyd Sigmon, chief engi[illegible] at KMPC

RMA Board of Directors for 1948-1949

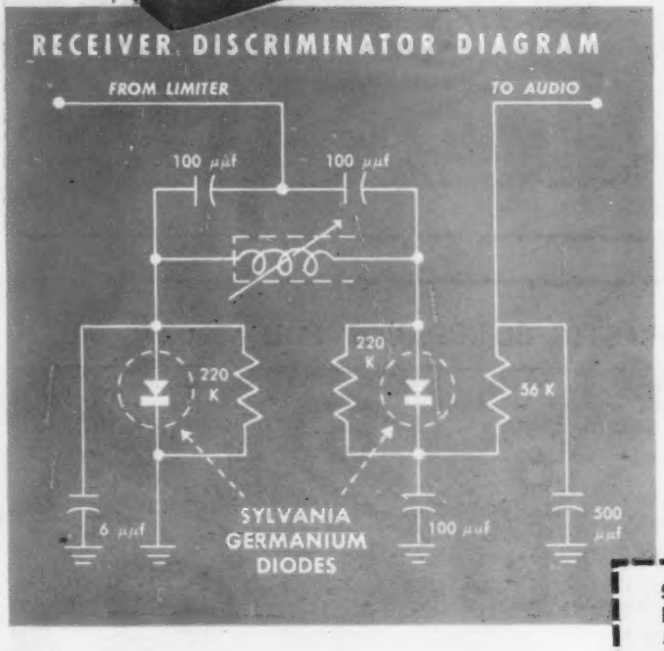
THE Motorola "HANDIE-TALKIE" UNIT IS SMALLER, LIGHTER, BECAUSE...

...it uses 2 Sylvania Germanium Diodes!

The Motorola "Handie-Talkie" unit has a range in excess of *two miles*. Yet it weighs less than ten pounds; overall dimensions are only 10" by 12⅝" by 3⅛".

An important factor in the smallness and lightness of this efficient unit is the use of two Sylvania Germanium Diodes in the receiver discriminator circuit. These diodes not only eliminate extra tubes, but, by reducing current drain, permit the use of smaller, lighter batteries. Motorola's own estimate of the difference if tubes were used instead: 10% increase in size, 15 to 20% in weight!

Perhaps you too, like Motorola and many others, can simplify the design of your equipment—or improve its performance—through the use of Sylvania Germanium Diodes. Start your planning by getting our literature.



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Berkeley, Chairman San Francisco Section IRE:

Signal to Noise Ratios of Linear Detectors, by R. H. DeLano of Hughes Aircraft Co.

A Mass Spectrometer Designed for Industrial Use, by C. E. Berry, R. L. Sink, and Carl Spaulding of Consolidated Engineering Corp.

Problems in the Design of Megawatt Output Klystrons for Pulsed Operation, by Marvin Chodorow and E. L. Ginzton of Stanford University.

Application of Microwave Spectroscopy to Determination of Interatomic Distances in Molecules, by D. K. Coles of Westinghouse Research Laboratory.

Saturday, Oct. 2

9:00 A.M. to 12:00 Noon—Chairman—C. N. Tirrell, Naval Electronics Laboratory, San Diego; Chairman San Diego Section IRE:

Systems Engineering Aspects in Military Communications, by W. S. Marks of U. S. Signal Corps Laboratories, Fort Monmouth.

The V.H.F. Omnidirectional Range, by C.A.A. Radio Development Division representative, R. E. McCormack.

Design of a Radar Set for Commercial Airlines, by F. G. Suffield, consulting engineer.

Design of Antennas for Optimum Directivity, by T. T. Taylor of Hughes Aircraft Co.

Band Width Reduction in Communication Systems, by W. G. Tuller of Melpar, Inc.

Television for Australia

TELEVISION ISN'T QUITE Down Under yet. The Commonwealth Postmaster General has invited bids for two experimental television transmitters, one each for Sydney and Melbourne. These would bring a third of Australia's population within line of sight.

A home television set with a 9-inch screen could be produced by Philips' Australian branch plant in about a year for $325, a spokesman of the company stated. But before the sets can be built, the government must promulgate transmission standards.

There is every indication that both television and f-m are to be a state monopoly; a-m radio is not completely nationalized yet, and a large number of commercial stations remain in operation.

Short-Wave System for East Africa

CONSTRUCTION WORK has begun on the first of 48 Marconi shortwave transmitters to be installed in East Africa to provide ground-to-air

(Continued on p 258)

MEETINGS

SEPT. 27-29: FM Association Second Annual Convention, Sheraton Hotel, Chicago, Ill.

SEPT. 27-OCT. 1: Third National Plastics Exposition, Grand Central Palace, New York.

SEPT. 30-OCT. 2: Pacific Electronic Exhibition and IRE west coast Annual Convention, Biltmore Hotel, Los Angeles, Calif.

OCT. 4-7: 53rd annual meeting of International Municipal Signal Assn., Inc., Hotel Statler, Buffalo, N. Y.

OCT. 5-7: AIEE Middle-Eastern District Meeting, Washington, D. C.

OCT. 7-9: Second joint meeting, URSI and IRE, National Bureau of Standards, Washington, D. C.

OCT. 12-16: Fifth National Chemical Exposition, Coliseum, Chicago, Ill.

OCT. 18-22: AIEE Midwest Fall General Meeting, Hotel Schroeder, Milwaukee, Wisconsin.

OCT. 23-29: Annual convention, American Society for Metals, Benjamin Franklin Hotel, Philadelphia.

OCT. 25-28: Annual Fall meeting of the Institute of Metals, Division American Institute of Mining and Metallurgical Engineers, Hotel Adelphia, Philadelphia.

OCT. 25-29: National Metal Exposition, Commercial Museum and Convention Hall, Phila.

OCT. 25-29: Annual Convention, American Welding Society, Bellevue-Stratford Hotel, Philadelphia.

OCT. 25-29: 64th semiannual convention, Society of Motion Picture Engineers, Hotel Statler, Washington, D. C.

OCT. 27-28: Annual Convention, Society for Non-Destructive Testing, Hotel Adelphia, Philadelphia.

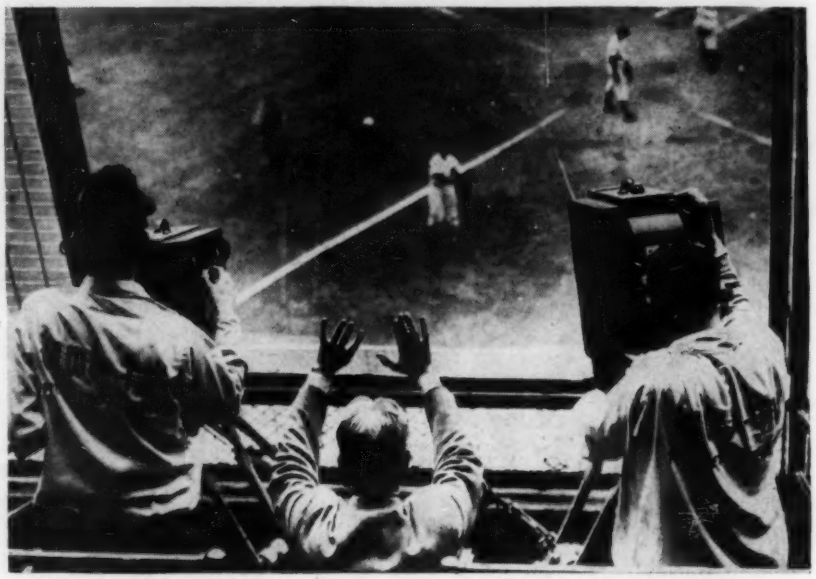
NOV. 4-6: National Electronics Conference, Edgewater Beach Hotel, Chicago.

NOV. 8-10: Twentieth Rochester Fall Meeting of members of IRE and RMA Engineering Dept., Sheraton Hotel, Rochester, N. Y.

NOV. 29-DEC. 1: Conference on electronic instrumentation in nucleonics and medicine, sponsored by IRE and AIEE, Engineering Societies Building, New York City.

NOV. 29-DEC. 4: 18th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York.

PLASTIC BOMBPROOF FOR VIDEO



This 7 x 8-ft slab of Plexiglas was recently installed by the Cadillac Plastic Co. of Detroit at Briggs Stadium in that city as a protection for television equipment. The ½-inch sheet will offset the impact of a 9-ounce ball travelling at over 100 miles per hour, according to researchers at Rohm & Haas Co., Philadelphia, makers of Plexiglas

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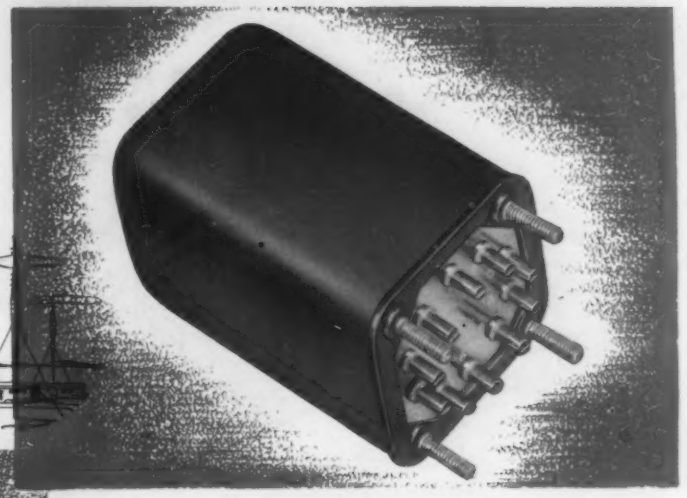
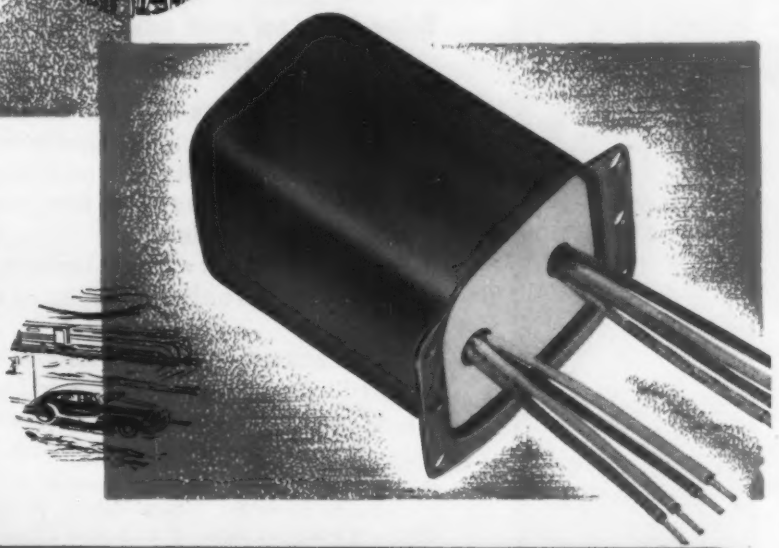
30 to 15,000 Cycles, provides uniform response over this entire band with ± ½ db up to 10 watts of audio power, within ± 1 db over 10 watts. Standard RMA impedances. Hum balancing coil structures and nickel alloy shielding. Included are Input, Output, Driver, and Modulation Transformers; Modulation Reactors. *Sealed in Steel* construction, stud mounting, with pin-type terminals.



Public Address Range

50 to 10,000 Cycles, frequency response within ± ½ db up to 10 watts of power, within ± 1db over 10 watts, throughout this range. Secondary impedances match 600 and 150-ohm lines, 16, 8 and 4-ohm reproducing systems. Listed are Driver and Output Transformers. *Sealed in Steel* construction, flange mounting, with solder lugs or wire leads.



Communications Range

200 to 3,500 Cycles, affords response with variations not exceeding ± 1 db over the range of voice frequencies. For use with 600 or 150-ohm lines. Input, Output, Driver and Modulation Transformers offered. *Sealed in Steel* construction, flange mounting, with wire leads or solder lugs.

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(continued from p 126)

control, a direct current is fed to an auxiliary coil on the head to buck out a portion of the earth's field. Thus the magnetometer is

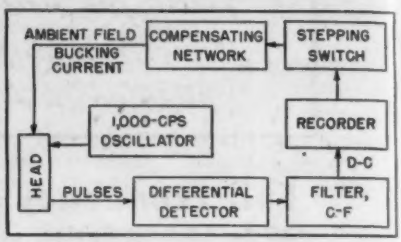


FIG. 2—Block diagram shows how pulses from sensing element are converted into direct current and fed to the recorder, and how a balancing current is obtained to restrict the range over with the head must operate

called upon only to measure the small unbalanced field. This bucking current is obtained automatically by a stepping switch actuated by the recording galvanometer as it reaches the end of its scale, shown in Fig. 2.

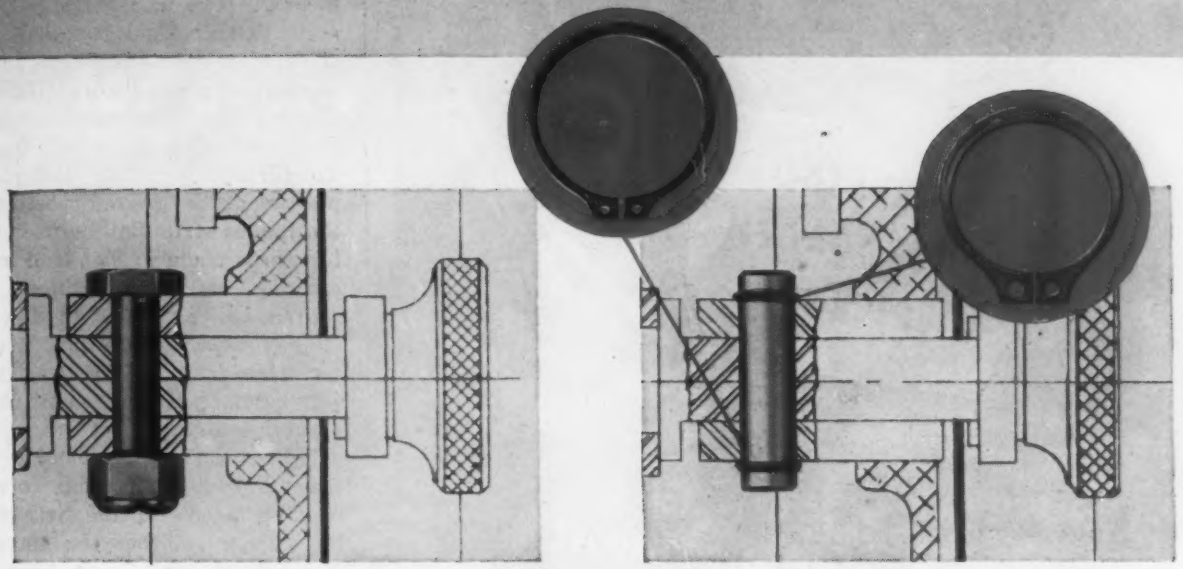
It is necessary that the sensing element be always oriented parallel to the earth's field for the recordings to have significance. This positioning is accomplished by a pair of orienting servos driving gimbals that are at right angles to each other. The sensing element is mounted on these gimbals.

Two auxiliary sensing elements can be used to detect the orientation of the earth's field. If the output from one of these auxiliary units is zero, it must necessarily be perpendicular to the earth's field. Thus these units are mounted mutually perpendicular to the sensing unit. The servo motors drive the auxiliary units to the positions at which their outputs vanish, thus placing the sensing unit parallel to the field. To avoid difficulties from the aircraft's magnetic field, the sensing element and its associated orienting mechanism are housed in a bomb-shaped "bird" that is lowered by its connecting cable to about 65 feet from the plane. The measuring and controlling circuits and recorder are carried in the cabin.

Reconnaissance Technique

Airborne magnetometers are calibrated at the laboratory and sent out to the field to be used in locating areas that can be expected to

Truarc saves 5 minutes, 9 cents in materials per unit without re-design of electric sanders



OLD WAY

Special ¼" cap screw and ¼-28 fibre-insert nut holds idler arm and pulley assembly on Model A3 "Take-About" Sander, Porter-Cable Machine Company.

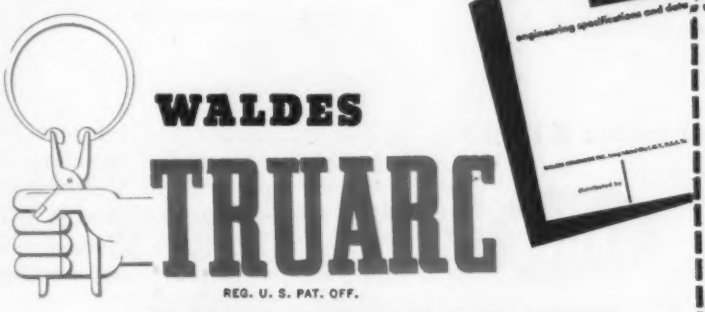
NEW WAY

Simple ¼" C.R. shaft, grooved in automatic screw machine, equipped with Waldes Truarc Retaining Rings. Bowed external ring (#5101-25) at top exerts resilient pressure taken up by Standard external ring (#5100-25) at bottom. Assembly is secure against vibration, can be easily taken apart and re-installed many times with same Truarc rings.

Every sander through the production lines costs 9 cents less for materials, requires 5 minutes less labor —with just the simple change from cap screw and nut to Waldes Truarc rings by Porter-Cable Machine Company, Syracuse, New York. The change to Truarc required no new design, no alterations in castings, but just the reappraisal of old methods.

Truarc can help you cut costs and increase production, too. Wherever you use machined shoulders, nuts, bolts, snap rings, cotter pins—there's a Truarc ring that does a better job of holding parts together. All Waldes Truarc Retaining Rings are precision engineered, remain always circular to give a never-failing grip.

Send us your drawings. Waldes Truarc engineers will be glad to show how Truarc can help you.



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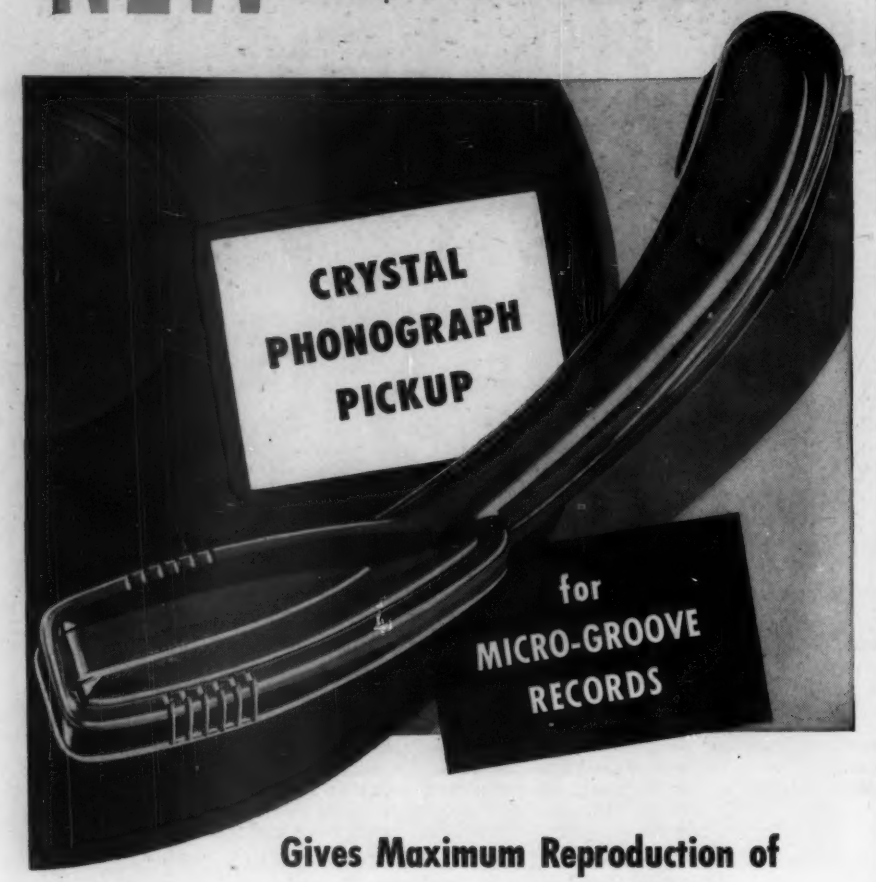

Gives Maximum Reproduction of Micro-Groove Record Fidelity

The Shure "900MG" Pickup is an ideal instrument for tracking on the new micro-groove records. It tracks at 7 grams . . . has a needle force of 9 grams as added safety factor . . . uses a special offset osmium-tipped needle with a point radius of only .001" . . . and has an output of 1 volt! The Shure lever system has been adapted in the development of this new pickup —providing a high needle compliance. Listen to it—you will be thrilled with the results!

Model "900MG" Code: RUZUZ List Price: $12.50

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contain oil-bearing strata. A flight crew surveys a region by flying a grid pattern consisting of flights about 75 miles long and a mile or so apart. The pilot flies the plane back and forth along such a grid, keeping accurately on course by means of two transportable shoran stations. The flight director aboard the craft constantly checks the shoran indications so that later, in plotting the measurements on a map, they can be accurately located. To further correlate the plane's position with ground position, a continuous strip film picture of the terrain is made so that land marks can be readily identified. The shoran indications, strip film and magnetometer recordings are all correlated by recording identical serial numbers at each position at regular intervals.

Later the measurements are transferred to maps thus forming magnetic profiles of the district. On the assumption that the magnetic fluctuations that have been observed are caused by changes in the depth of the igneous bed (or basement) rock, the geologist predicts in what places domed formations likely to contain oil will be found. Of course other magnetic disturbances might have produced the observed contours. The know-how of geologists consists in recognizing the characteristics of the different factors that influence the slight local field contours.

Once a region has been located that appears a likely prospecting area, seismographic parties make detailed examinations to verify the inferences. These two techniques, magnetometer and seismograph surveying, relying heavily on electronics, are proving extremely valuable in the race to find oil as fast as it is being consumed.

RPM Counter

TURBINE components for new jet engines are whirled at close to 100,000 rpm and in temperature of 1,750 degrees F at Boeing Airplane Co. propulsion laboratory in proving jet engines under development.

An electronic rpm counter measures the speed of the wheel as it spins. One end of the spinning

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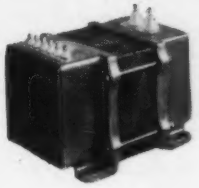
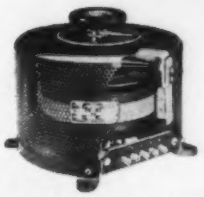
for every electronic application

Liquid Immersed Plate Transformers—AmerTran oil and Abestol immersed, for indoor and outdoor service—precise overvoltage protection by means of bushing mounted sphere gaps.



"W" Dry-Type Transmitter Components—Economical self-cooled transformers and reactors—for more efficient rectifier operation.

Hermetically Sealed Transformers—Highly resistant to moisture, shock, pressure and temperature variation. Either liquid-immersed or compound filled.



Transtat Type TH for .3 to 20 KVA—Manually operated a.c. voltage regulator providing arcless, stepless control. Brush track on coil periphery where it may be banded to insure trouble-free operation under exacting conditions of service.

PERHAPS your transformer problem calls for design and development. Maybe you require large transformers in small quantities. Or possibly you'd like to obtain the benefits of mass production and need transformers in large quantities.

No matter what your transformer requirements, you will find AmerTran engineers can solve them—efficiently and economically.

In almost half a century of specialization, we have acquired a "know-how" and "can do" which are unsurpassed in the transformer industry. Typical applications of this background are the transformers shown on this page.

Our experience is ready and waiting to go to work on *your* transformer problem. Call in AmerTran today to tell you how we can give you *the* transformers you need . . . *when* you need them . . . at prices made possible only by real manufacturing efficiency

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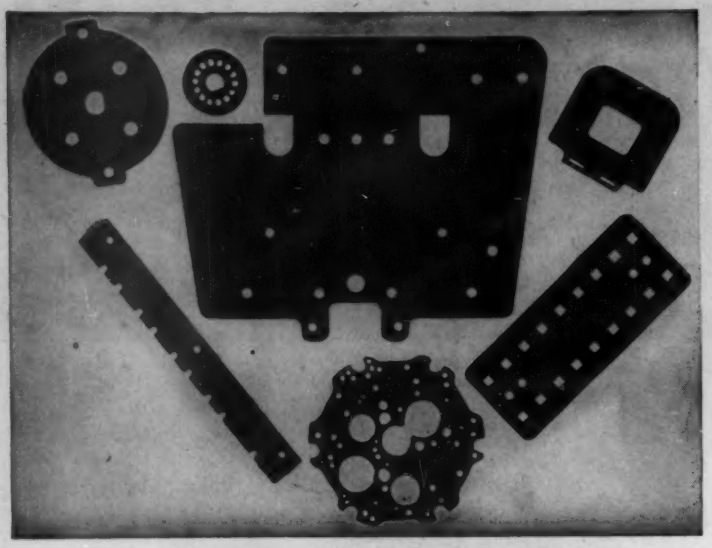

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Galvanometer available separately if desired

PERMANENT Records
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NO INK
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RECTILINEAR Writing
•
RUGGED Construction with EXTREMELY HIGH torque movement (200,000 dyne cms for 1 cm deflection)

While designed primarily for use in the Sanborn direct-writing electrocardiograph (the Viso-Cardiette) this assembly (or the galvanometer alone, if desired) has sufficient potential value for varied industrial applications to warrant this announcement of availability for non-medical uses.

The complete unit illustrated comprises the galvanometer and writing arm, with associated paper drive (No. 572M—500). The galvanometer and writing arm are available as a separate unit (No. 572M—300). Recording styli available in two types; fine line writing approximately 1/3 mm; wide line writing approximately 1 mm. Recording paper can be furnished in 200 ft rolls, 6 cm wide (No. 572-737-P3).

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Coil resistance	3,000 ohms, center tapped for push-pull operation.
Critical damping resistance	500 ohms.
Undamped fundamental frequency	45 cycles/sec.
Stylus heater requires from external source	1.25 volts, 3.5 amps, AC or DC
Maximum undistorted deflection	2.5 cm. each way from center
Marker requires from external source	1.25 volts, at 1.5 amps, AC or DC
Paper speed	25 mm/sec.
Chart ruling	1 mm intervals

In the development stage are other Sanborn "medical recording" instruments which have apparent industrial applications. These include an Electromanometer for direct measurement of "pressures", and several models of multi-channel (2 to 6) recorders, both direct recording and photographic.

For complete information write, giving details of proposed application to

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NEW!...the Roto Ranger

—automatically rotates one of 18 separate scales into position as you select the range.

SIMPSON MODEL 221 ROTO-RANGER
HIGH-SENSITIVITY A.C.-D.C. VOLT-OHM-MILLIAMMETER

Here is the only multiple scale test instrument of its kind in the world. It definitely reduces the possibility of errors by providing a single scale for each range of this finest of volt-ohm-milliammeters. As the selector switch is moved to the range desired, an ingenious gearing mechanism rotates a drum, bringing into place behind the meter window the proper scale for that range. Here is the equivalent of 25 separate instruments combined in one sturdy and compact unit. (18 scales; 7 additional direct reading ranges through use of high voltage and output jacks.) The patented Roto-Ranger principle eliminates the confusion of numerous readings on one scale, and the multiplying factors common to ordinary multi-range testers, by providing a separate scale for each range. There are no cramped calibrations in these full sized Roto-Ranger scales. Each is designed as it would be for a separate instrument.

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- 20,000 Ohms per Volt D.C., 1,000 Ohms per Volt A.C.
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- Milliamperes, D.C.: 10, 100, 500
- Microamperes, D.C.: 100
- Amperes, D.C.: 10
- Output: 2.5, 10, 50, 250, 1000
- Ohms: 0-2000 (12 ohms center), 0-200,000 (1200 ohms center), 0-20 megohms (120,000 ohms center).
- Size: 12¾" x 10⅛" x 5⅜"
- Weight: 8 lbs. 9 oz.
- Price, complete with test leads and 28-Page Operator's Manual..... $69.85

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Spin pit for testing turbine parts. Speed is measured by an electronic rpm counter. The mercury flash lamp held by the Boeing engineer permits photographs at 0.2-microsecond exposure

turbine shaft is divided into two sections, half black, half white. A phototube, focused on the shaft, sends a current impulse to recording instruments each time the black portion passes its scanner. Timed and checked electrically, the speed is controlled within one-half of one percent accuracy.

The spinning is done in pits made up of layers of steel plate, with maple blocks on the inside. The steel shells test turbine components. Power for the tests is derived from compressed air, driving a small turbine which, through a shaft, is attached to the test article. A hoist supports the heavy weight of the cap plate, air turbine and accessories. The entire assembly is lowered into the pit, clamped in place and the air evacuated.

One pit has built-in heating coils of nichrome steel wire imbedded in clay holders to maintain constant temperatures of up to 1,750 deg F. Automatic controls keep temperature to preset levels and also record the whole test. Highspeed rotation and extremely high temperatures combine to prove each new development in turbine parts before incorporation in an actual engine.

High-speed photographs, made with an ordinary 8 x 10 view camera, enable engineers to study test wheels as they break. A small mercury lamp is the light source for the one five-millionths of a second flash. The tripper con-

Another FEDERAL First!
INTELIN K-109
Crimped Type Coax

...for permanent automotive lead-ins

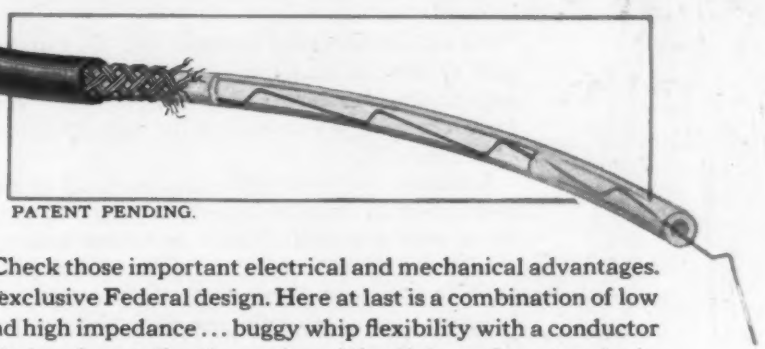
Efficiency – combining low loss and low capacity for high fidelity transmission with minimum attenuation and signal distortion

Flexibility – new ease of handling, installing and maintaining

Shielding – for freedom from interference

Permanent Conductor Set – for electrical and mechanical stability

Spring Action – Eliminates necessity for providing slack in conductor when connecting terminals. Minimizes conductor breakage at the terminals.



PATENT PENDING.

Check those important electrical and mechanical advantages. Check the exclusive Federal design. Here at last is a combination of low capacity and high impedance ... buggy whip flexibility with a conductor that soaks up vibration and won't break away from terminals.

Federal's new Intelin K-109 Crimped Type Coax has everything for rugged service. It is also recommended for aircraft and marine antenna lead-ins ... for inter-stage audio connections in general radio and electronic equipment.

Perhaps you see other uses for K-109. For full technical information and prices, write to Department D-613.

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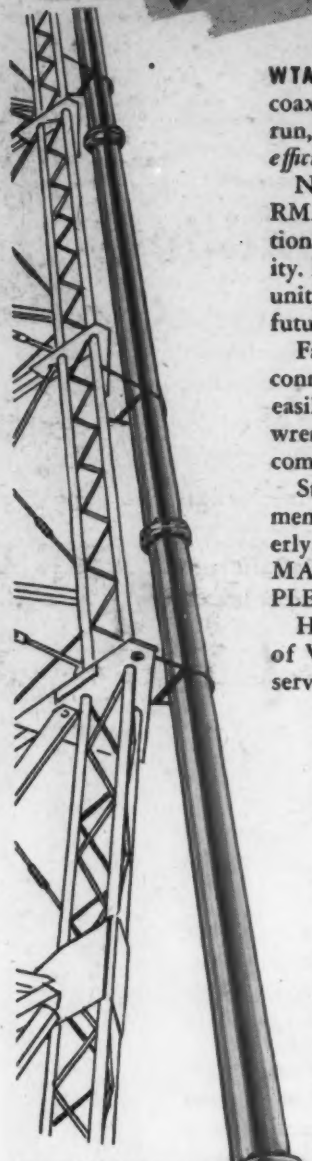
ANDREW



WTAD-FM did. That's why they selected Andrew 6⅛" coaxial transmission line. In spite of the 800 ft. long run, including a 750 ft. run up the tower, *the overall efficiency is 90%!*

Not only is this 6⅛" line the most efficient standard RMA line used in broadcasting, but it offers the additional advantage of very high power handling capacity. It will handle up to 166,000 watts at 100 MC with unity standing wave ratio, allowing a wide margin for future power expansion.

Fabricated by Andrew in twenty foot lengths with connector flanges brazed to the ends, sections can be easily bolted together with only a couple of small wrenches. Flanges are fitted with gaskets so that a completely solderless, gas-tight installation results.

Still another advantage to buying Andrew equipment is that Andrew engineers are available to properly install it. NO OTHER TRANSMISSION LINE MANUFACTURER OFFERS YOU THIS COMPLETE INSTALLATION SERVICE!

Here's what Mr. Leo W. Born, Technical Director of WTAD-FM, writes about Andrew installation service:—

"You will be interested to know that the installation of the Andrew coaxial line made by your organization has been giving us trouble-free performance of high efficiency in the daily operation of WTAD-FM.

Knowing the great difficulties involved in the installation of such a large line on a 750 foot tower over a period of such inclement weather conditions, I feel that the excellent operation of the line is indeed a tribute to the men of your company who were on the job. Such performance is not accidental and we congratulate you on a tough job well done."

This again emphasizes Andrew's unique qualifications:—Unsurpassed equipment and complete engineering service.

The 750 ft. high tower of WTAD-FM, Quincy, Illinois — one of America's finest FM Stations—showing 6⅛" copper coaxial transmission line manufactured and installed by Andrew.

WANT THE MOST EFFICIENT ANTENNA EQUIPMENT FOR YOUR STATION? WANT EXPERIENCED ENGINEERS TO INSTALL IT? WRITE ANDREW TODAY!

Andrew CORPORATION

TRANSMISSION LINES
ANTENNA EQUIPMENT

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sists of double concentric copper screens which line the test pit. At burst, the pieces of the test wheel crash into the screens, pushing them into contact and completing the flash circuit. By this technique, any portion of the wheel which breaks loose under such punishment immediately takes its own picture and establishes the point of failure.

The spin pits test the turbine wheels for the effects of weight and tensile strength of the materials; for rim-loading by their blades; profile, or cross-sectional shape; design of the shaft holes in their hubs.

Metal Picture Tube

A sixteen-inch cathode-ray tube having a metal shell is being made available to receiver manufacturers.

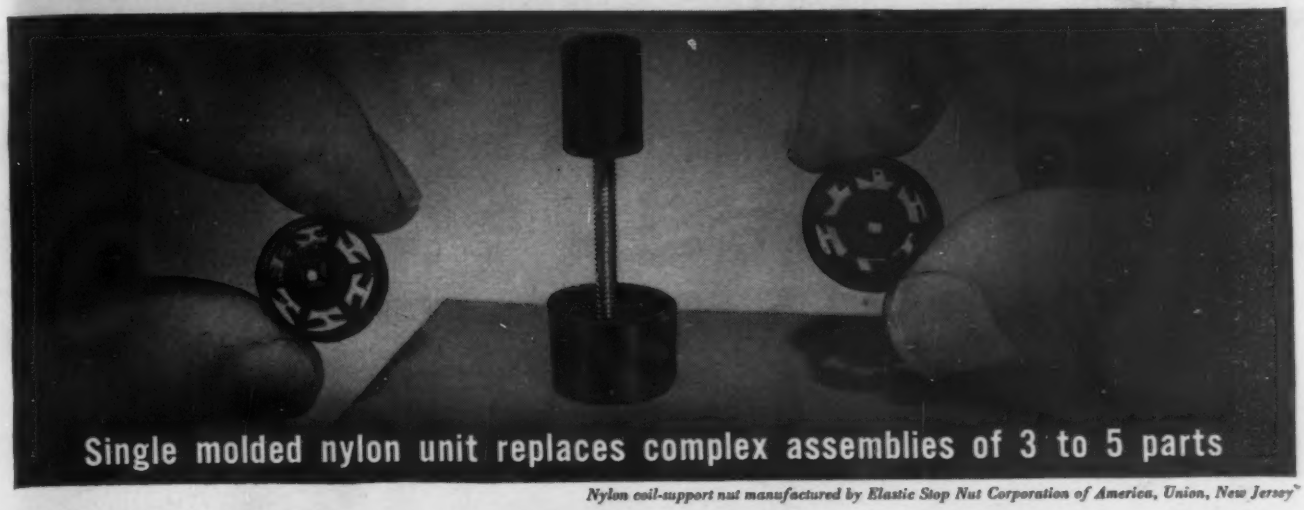
The envelope of the new tube consists of a cone of spun chrome steel alloy. A glass neck houses the electron gun assembly to permit customary mounting and operation of the focusing and deflection coils. The glass neck flares outward to a diameter of about four inches and meets the metal cone in a butt joint. Sealing the metal, which has the same coefficient of expansion as the glass, is accomplished with the aid of induction heating.

The glass front of the picture tube is drawn glass, polished on both sides, and this too is sealed to the metal cone with induction heating. The curvature of the glass face is such that nearly

New metal-shell picture tube

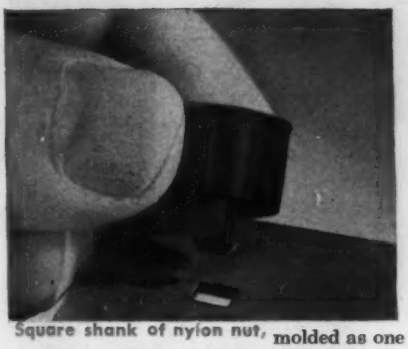
ONE-PIECE NYLON SUPPORT NUT

simplifies coil assembly . . . speeds up production

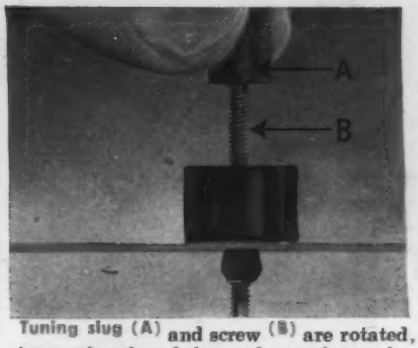


Single molded nylon unit replaces complex assemblies of 3 to 5 parts

Nylon coil-support nut manufactured by Elastic Stop Nut Corporation of America, Union, New Jersey



Square shank of nylon nut, molded as one unit but consisting of four separate prong-shaped legs, is inserted in square hole of supporting plate. Since nylon itself is an insulator, the nut does not require a grommet. And Du Pont nylon remains stable at temperatures ranging from – 60°F. to 200°F.



Tuning slug (A) and screw (B) are rotated, impressing thread shape of screw into nylon shank. Prong-shaped legs of shank flare outward, securing nut to plate. Nylon develops torque on screw thread to hold slug in adjusted position, despite vibration and variations in plate thickness and size of hole.

Coil form fits snugly in nylon nut . . . firmly gripped externally by six thin, flexible "fingers" on the inside wall of the support nut. The hollow tube is held securely in place by pressure of the nylon "fingers," although wall thicknesses of the tube may often vary as much as 1/32 of an inch.

CAN NYLON HELP YOU MAKE A BETTER PRODUCT?

Here's a new, all-nylon coil support for radio and television sets. It does the same job that once required a complex assembly of 3 to 5 parts . . . yet it consists of only *one molded nylon nut!* The result—reduced parts inventory, quicker assembly, faster production.

In developing this new product, the manufacturer found all the desired properties in Du Pont nylon. Its light weight, strength in thin sections, resiliency, stability and insulating properties permit a new, multi-purpose design. And nylon's unique workability assures efficient, economical molding of the intricately shaped unit. *It's one more case* where an electrical manufacturer makes a better product with Du Pont nylon.

This Du Pont plastic can be molded or extruded. When designing electrical parts or wires, don't overlook its remarkable properties. Write for free booklet, "65 Success Stories of Product Improvement." Filled with helpful facts. Just address: E. I. du Pont de Nemours & Co. (Inc.), Plastics Department, Room 1410, Arlington, N. J.

CHECK THESE 7 BASIC FEATURES OF NYLON FOR ELECTRICAL USES

1. Good flexibility
2. High tensile strength
3. Extreme toughness
4. Abrasion resistance
5. Resistance to permanent set
6. Chemical resistance
7. Ability to be molded or extruded

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. . . THROUGH CHEMISTRY

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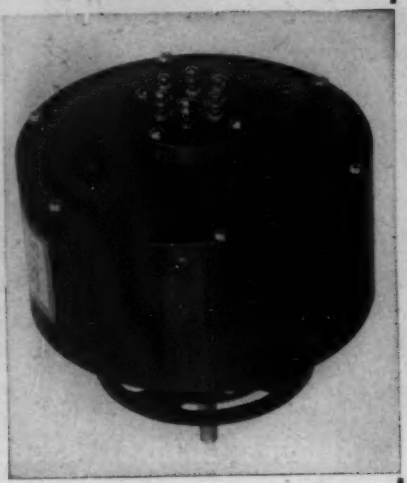
For use in computing and analyzing devices; generation of low frequency saw tooth and sine waves; controls for radio and radar equipment; position indicators; servomechanisms; electro medical instruments, measuring devices—telemetering; gun fire control where 360° rotation, high precision and low noise levels are essential.

The type RL14MS sinusoidal potentiometer is illustrated. It is wound to a total resistance of 35,400 ohms and provides two voltages proportional to the sine and cosine of the shaft angle. It will generate a sine wave true within ±.6%. Overall dimensions are 4¾" diameter x 4 11/32 long plus shaft extension ¼" diameter x 1¼" long.



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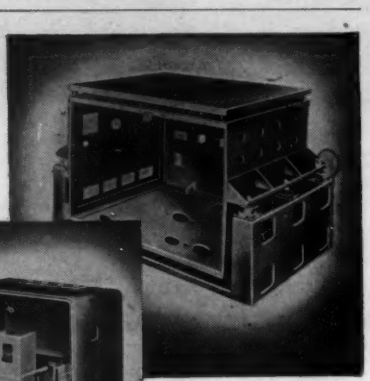
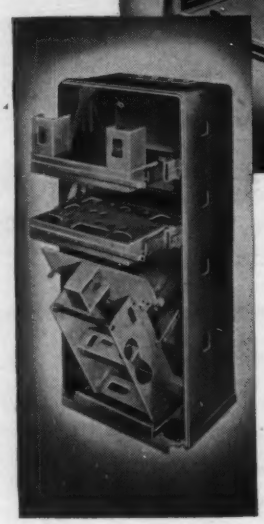
to your specifications . . .





COMPLETE facilities under one roof for quantity mass production—including welding, baking and finishing. Whistler and Wiedermann equipment for short runs. Tool and die engineering and designing.

Substantial sheet steel inventories permit speed, service and cooperation. Large assortment of stock and special dies for the radio and electronic field. Production and engineering under the personal direction of Mr. E. B. Gunzburg, president—who has had 34 years' experience in sheet metal fabrication.

Quality chassis, metal cabinets, instrument housings, panels, boxes, metal parts and stampings—sample models—in stainless steel or in any metal or any gauge. Close tolerances guaranteed.

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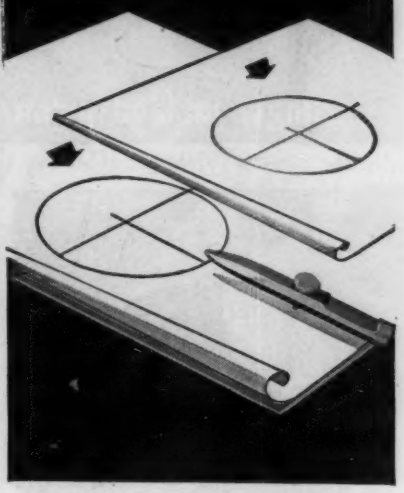

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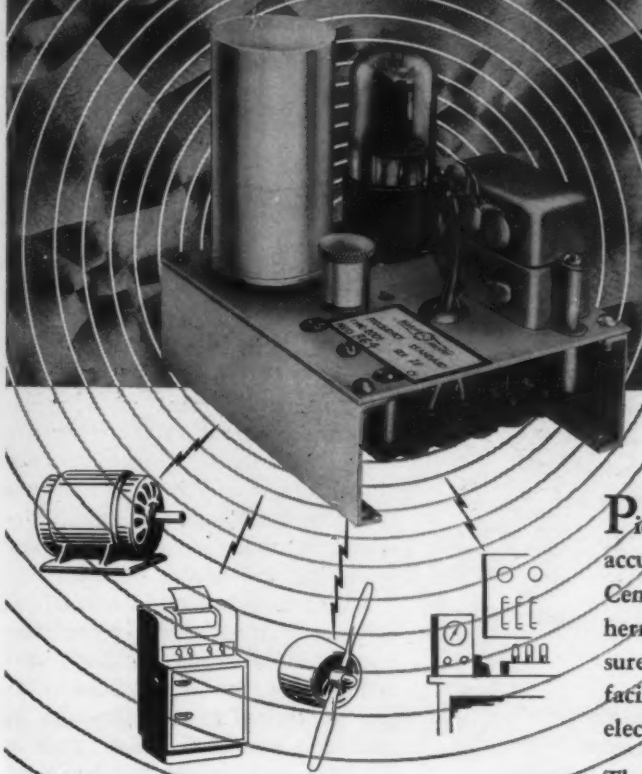

Pictured here is a tuning-fork frequency standard with accuracy guaranteed to one part per million per degree Centigrade. The fork is temperature-compensated and hermetically sealed against variations of barometric pressure. This standard, when combined with basic equipment, facilitates accurate speed and time control by mechanical, electrical, acoustical or optical means.

The unit is available separately or in conjunction with complete timing instruments. Our engineers are ready to cooperate on any problem.

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Where electrical contact is required to a moving part, laminated precious metal rings offer unusual operating characteristics at a real saving in cost over solid precious metal rings.

Silver or Gold, or Platinum, or Palladium, or their alloys, bonded to the required base metal, such as copper or bronze alloys, make possible . . .

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150 sq in. image area is provided.

The 16-inch tube has a deflection angle of 53 degrees and, for critical resolution, deflection coils designed for this angle are recommended. However, coils designed for conventional tubes having a deflection angle of 50 degrees have been found to provide good resolution. Operating voltage of the second anode is recommended at about 10 kv although the tube is tested at 15 kv.

The potential of the steel shell is also 10 kv and it is planned to make available an insulating sleeve. A Tenite coating on the sleeve and an Aquadag layer might then be used to form a filter capacitor for the high-voltage power supply as is conventional practice with the 10BP4 and 10FP4. (ELECTRONICS, p 186, April 1948).

The metal tube is manufactured by Tel-O-Tube Corp. of America, at Paterson, N. J. and is used in a table model receiver of Starrett Television Corp. of New York.

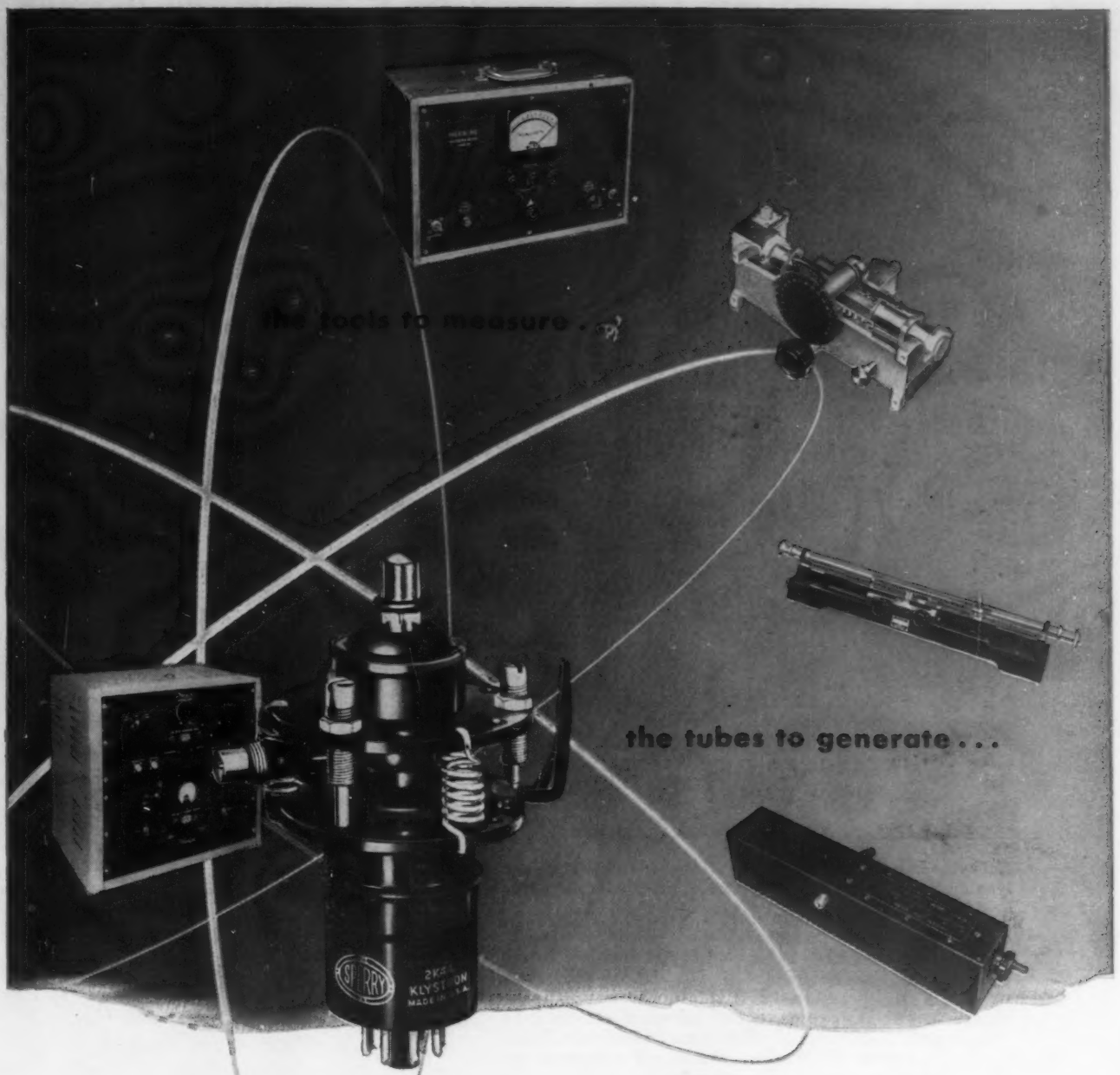
Amplitude Selective Amplifier

By CHARLES E. LOWE
Fenton, Michigan

IN THE development of a servo-system for operation of a drag cup motor in response to the output signal of a magnetic bridge, it was found that the use of an amplitude-selective amplifier overcame many irritating and vexing problems.

Slight modification in normal resistance-coupled amplifier performance enables such amplitude discrimination to be obtained with few additional parts. Although in ordinary amplifier usage such a condition is known as bad transient response, in this application it acted as a cure-all with no ill effects.

The output signal of the magnetic bridge contained much second harmonic of the motor operating frequency throughout the near-balance condition of the bridge and through the null point of the operating signal. This unwanted harmonic content tended to mask the null point as it decreased the sensing efficiency of the overall system at the critical time of balance indication. At the same time, the non-linear operation of the bridge magnetic elements combined with the



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These Sperry products equip the research or development engineer with every essential for development or design in the microwave field.

The Sperry Klystron Tube has already opened up new vistas in navigation, aviation, medicine, radio, telephone, telegraph and other major applications. It is ready for many new local oscillator or high power uses.

The Sperry Microline includes practically every type of instrument for quick precision measurements in the microwave frequency bands.

This Sperry service — beginning with a source of microwave energy, the Klystron, and following through with every facility for measuring microwaves — opens up almost unlimited possibilities for industry.

We will be glad to supply complete information.

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Model 650
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Flat out to 15 kc! Extremely high output! Impedance selector! Dual-type shock-mount! Remarkably rugged! Individually calibrated!

Developed in cooperation with station and network engineers, the new "650" and "645" meet exacting requirements of modern high fidelity FM and AM broadcast service. Proved in studio and remote use. Polar pattern is non-directional at low frequencies, becoming directional at high frequencies. Recessed switch gives instant selection of 50 or 250 ohms impedance. Exclusive Acoustalloy diaphragm withstands toughest use. Many other important features assure the ultimate in broadcast quality. Satin chromium finish. Fully guaranteed.

Model 650. Output level —46 db. List **$150.00**
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differentiation through the mutual inductance of the output winding, coupled to the bridge proper, created an output signal inconsistent in waveform. As a result, the speed of the motor did not bear a simple direct relationship to the primary control displacement and the final calibration of the system became partially dependent upon an unreliable and erratic variable.

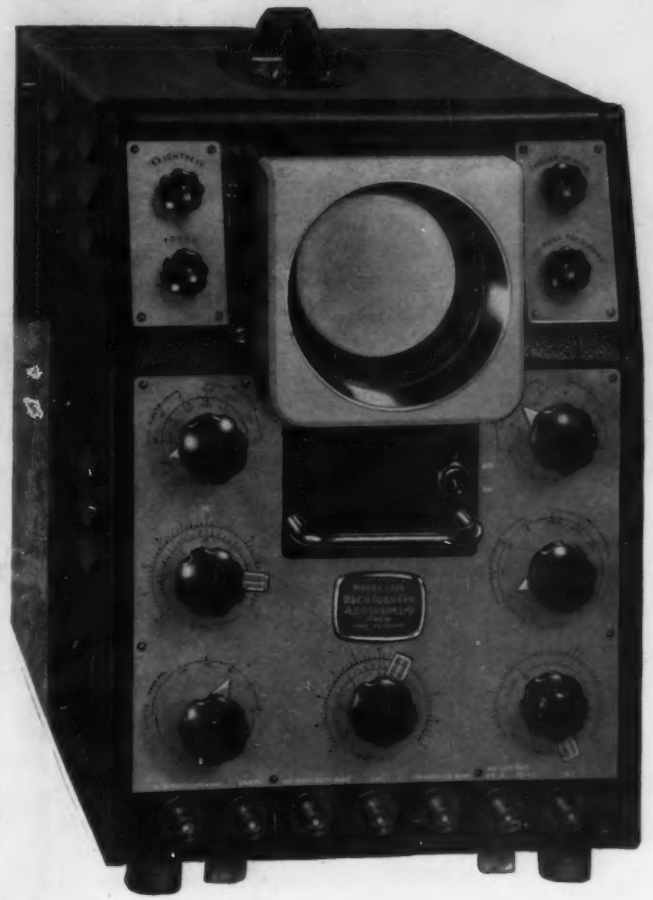
Presence of the second harmonic of the bridge excitation frequency in the bridge output signal was a necessary evil of the bridge design. Since it was designed to respond to minute direct currents in its input winding and to sense their direction as well as their amplitude, it was necessary to polarize the bridge arms with direct-current magnetization. In this way the aiding or opposing of this steady flux by the flux set up by the small current from the primary conversion element produced effects that indicated the direction of such current by the phase relationship of the output signal to the bridge excitation frequency. This latter frequency was also one of the phases of the motor excitation.

The sensing of reversal of input current direction by the bridge was indicated to the drag cup motor by a 180-degree change in phase of output signal. A balance for the bridge occurred with no incoming current from the conversion element or with the bridge input terminals shorted. At balance, the opposing alternating-current fluxes from the two bridge arms failed to give zero signal balance indication.

Since each half cycle of the opposing fluxes operated in separate directions along the B-H curve of the core from the operating point set up by the d-c polarization, the peak amplitudes of each half cycle of flux were not equal. Because of this difference, cancellation was not complete, and during every half cycle of the excitation frequency such a left-over bundle of flux appeared to cyclically excite the output winding. Thus, a second harmonic signal is generated. This signal reached its maximum value at the time of the null for the motor-operating signal.

In this application, the drag cup

The latest COSSOR CONTRIBUTION to electronic technique!



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DIRECT measurement of time intervals

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COSSOR* TWIN-BEAM OSCILLOGRAPH MODEL 1035

A. C. Cossor Ltd., pioneers in the fields of advanced electronic equipment, including the development of the cathode ray tube, now, with pardonable pride, offer the COSSOR TWIN-BEAM OSCILLOGRAPH to the electronic industries of North America.

In all fields of modern research and in all industrial laboratories — in fact, anywhere where competent quantitative measurements and immediate waveform analysis are a necessity, the Cossor Twin-Beam Oscillograph, Model 1035, is essential equipment.

The instrument design incorporates a high speed, linear repetitive time base, featuring "Flyback" suppression with further facilities of external triggering from both positive and negative synchronizing voltages. The time scale is liberally spread over 9 convenient ranges, 150 milliseconds to 15 microseconds, and the time base waveform may be fed out for use with other equipment.

Other important factors which make this a really unique oscillograph, are the two independent systems of amplification with similar calibration arrangement. Voltage scale of amplifier Y1 covers 7 ranges, 50 volts to 50 millivolts, having an efficient frequency response of 10 mcs. to 20 cps. Voltage scale of Y2 covers 5 ranges, having a frequency response of 100 kcs. to 20 cps.

Still another major technical advancement lies in the electrically shielded new Cossor type 89 Double-Beam tube, 4 inches in diameter, with a FLAT FACE, eliminating all possibility of distortion created by the conventional curved-faced type, and, in addition, the graticule is engraved on both sides eliminating the common optical aberrations of parallax.

The instrument provides for mounting a camera directly to the face of the Cathode tube thus providing a permanent record of the waveform displayed.

Mains voltages may be adjusted between 105 to 255 volts and frequency between 50-100 cycles; power consumption 170 watts.

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**The A. C. Cossor organization has won world-wide recognition for its pioneer development of the X-Ray Tube, the Cathode Ray Tube and the Cathode Ray Oscillograph. It also developed the first Radar Receiver and the first commercial Television Receiver.*

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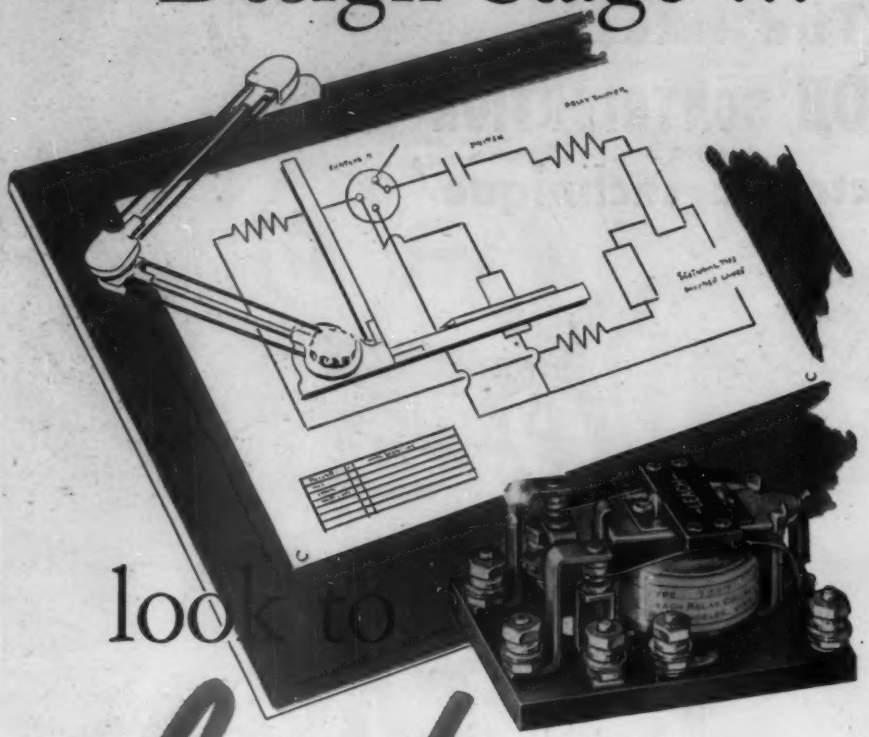
While it's "in the Design Stage"...



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Leach manufactures thousands of types of relays, for thousands of applications. Many are production items which may offer you savings in delivery time and unit cost. Through a slight change in circuit design you may gain the advantages of a standard type, at considerable savings *and* do a better job.

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motor is subject to a braking action in the presence of such harmonics, distortion, or spurious frequencies, and mainly suffers a loss of efficiency and is not made unusable. Because of the limitations on the amplifier at a time when its sensitivity should be increased and the very irregular action of the servo-system as the control signal waveform varied, steps were taken to eliminate this nuisance.

Application of tuned circuits and of notch filters helped but reliability under varied conditions of operation was not obtained.

Circuit Operation

In the process of amplitude discrimination, the output signal of the bridge is first amplified and then the fundamental frequency is separated from the envelope of the second harmonic. The output of the amplifier goes through essentially the same waveform changes as the input signal with the exception that the output signal change occurs long before the same degree of input signal change. Watching the input and output signal simultaneously on a pair of oscilloscopes, one can observe only a slight change in the waveform of the input signal while the output signal is changing from complete second harmonic to complete fundamental. The change in output signal during the transition is continuous in that one frequency increases in amplitude while the other is decreasing.

At bridge balance, the amplifier still passes second harmonic signal, however, it is now limited to a much narrower range in the bridge calibration. The increased sharpness of bridge balance indication welcomes the damping action induced on the motor armature by the second harmonic drag. Thus the braking action of the second-harmonic signal of the motor operating frequency may be used for slight anti-hunting purposes to inhibit overshooting.

Bridge Signals

Figure 1 shows the changes in the bridge output from a balanced condition to one of complete unbalance. At Fig. 1A, the balanced bridge indication is an approximate sine wave, a second harmonic

POPULATION-0

Even in the most remote areas, wings aloft are guided on their way by Aerocom's new medium range Aerophare Transmitter. This transmitter was designed and built to provide long, trouble-free service with no attendants . . . even where the total population is Zero.

AEROPHARE

The 100 Watt Aerophare illustrated consists of the following units--AK-3 automatic keyer; Model 100XL transmitter, (100 Watt carrier power, minimum of 30%-high level tone modulation for identification but with no provision for voice modulation); and antenna matching unit.

The smaller unit is similiar, except transmitter is of 50 Watts carrier power with 90% high level tone modulation for identification, or, 90% high level voice modulation. Microphone P-T-Switch, when depressed interrupts tone, permitting voice operation. This feature makes this unit ideal for airport operation where both aerophare and traffic control are needed.

Both units are completely "tropicalized" to allow operation under unusual climatic conditions. Each unit is ruggedly constructed and conservatively rated, providing low operating and maintainence costs. Engineering data on both units upon request.

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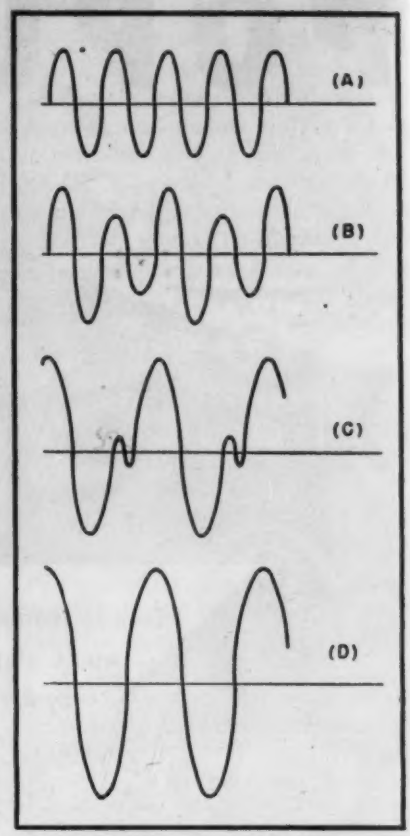

FIG. 1—Bridge output signals showing transition from second harmonic to fundamental to indicate various degrees of unbalance

of the bridge excitation frequency. All of these peaks are of equal height. In Fig. 1B the peaks alternate in height and indicate a slight bridge unbalance for this is a sign of the fundamental making its appearance from the null value. In Fig. 1C, the unbalance has progressed to almost complete disappearance of the second harmonic component. In Fig. 1D, the final output of complete unbalance is an approximate sine wave which has a phase determined directly by which of the alternate set of peaks in Fig. 1B increased in height. If the bridge unbalance had progressed in the opposite direction, the resulting complete unbalance signal would have had a phase difference of 180 degrees from the phase shown.

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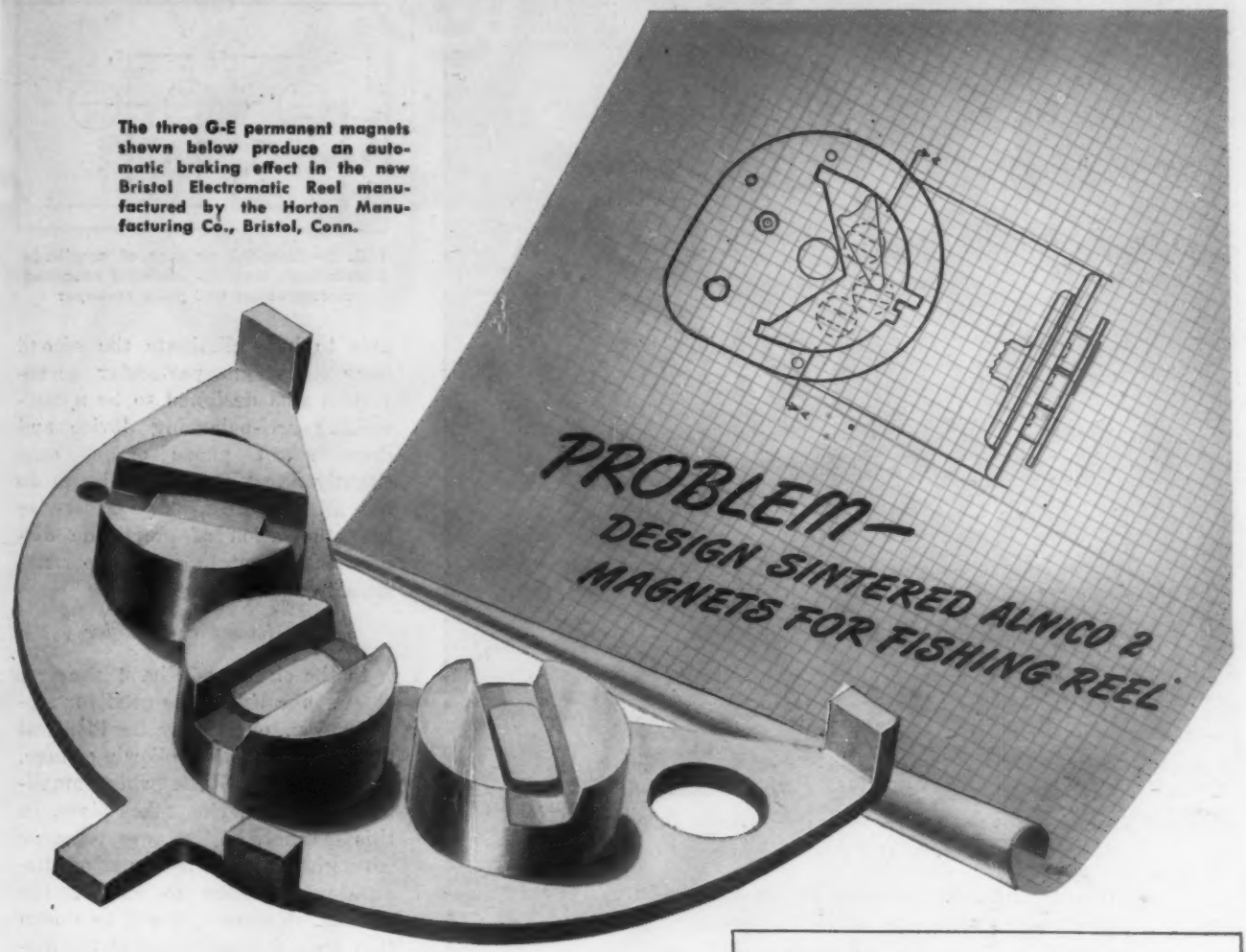

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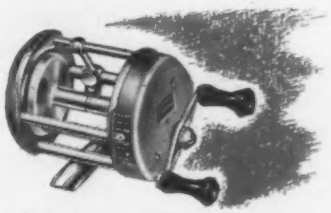

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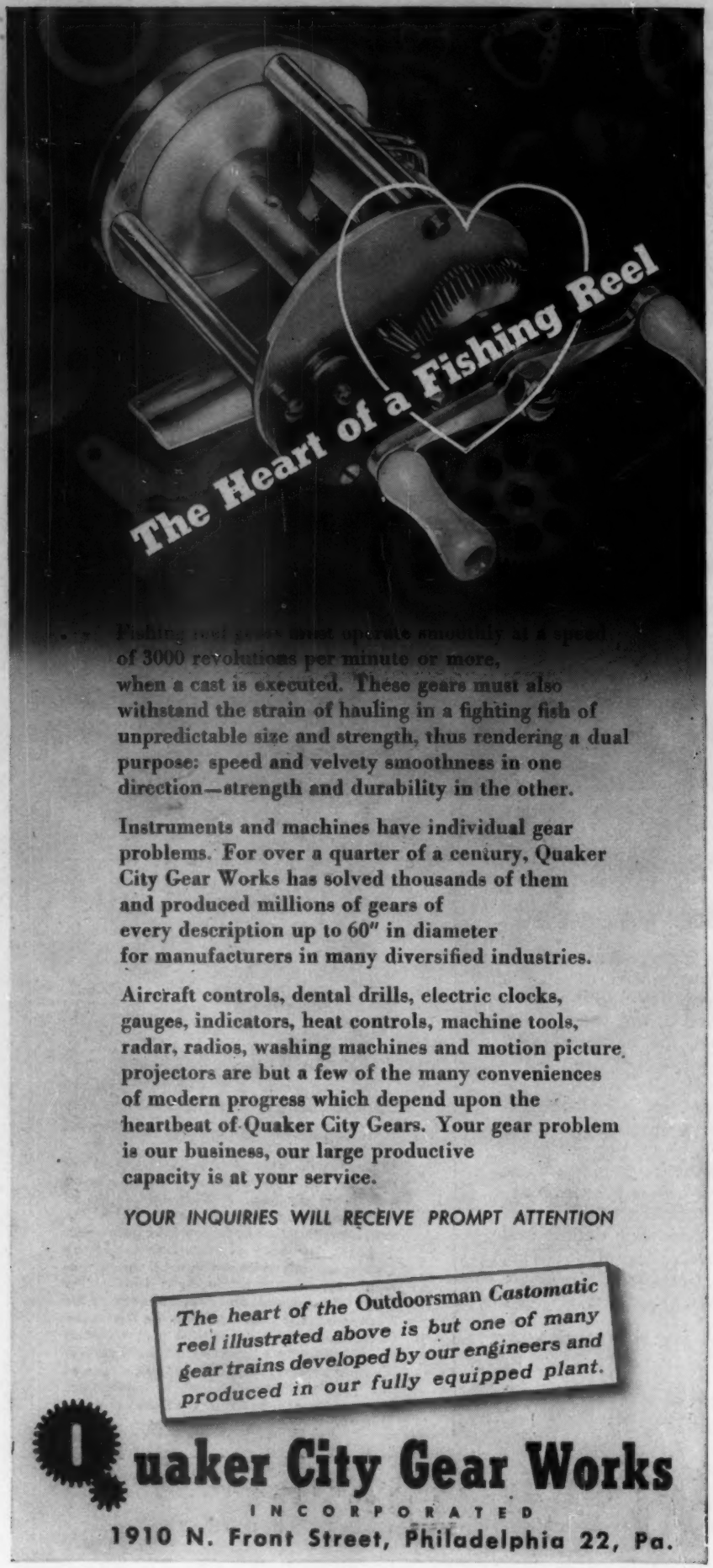

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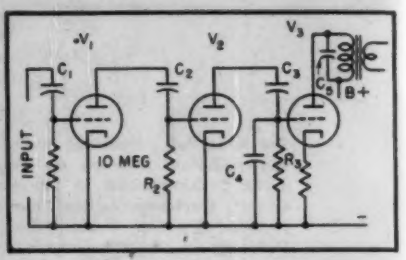

FIG. 2—Essential portions of amplitude discriminator amplifier showing cascaded discriminators and pulse reshaper

axis to help eliminate the second harmonic. This particular servo-system was designed to be a null-seeking self-balancing device and these slight phase errors only slightly affect motor speed and do not affect calibration. Otherwise the application of amplitude discrimination might not be permissible to such a system.

Discriminator Amplifier

In the circuit of Fig. 2, the first stage, tube V_1, can be used for amplification, or it may be identical in action with the following stage, including tube V_2, in which amplitude discrimination takes place. In this manner, both stages together may give a cascaded type of discriminator action to extra large signals. However, it will be shown that amplification ahead of the discriminator is most desirable in that it increases the rapidity with which the circuit indicates unbalance. This is similar to increasing the Q of a tuned circuit. Tube V_3 is a driver for the motor-operating stage. It delivers a sine wave at the output of the driver transformer T_1 for the rectangular input from the effects of amplitude discrimination ahead of it. This motor-operating sine-wave output remains almost constant up to the point of complete bridge balance at which time it rapidly changes to second harmonic of the bridge excitation frequency.

The motor-operating signal had a frequency of 60 cycles to be adaptable to standard power line supply as well as portable power generation. Tubes V_1 and V_2 are normally biased by the contact potentials developed at their grids. However, in operation the positive peaks of the signal may draw grid current and so bias the grids to a value below cut-off in an amount

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essentially equal to the signal amplitude. The time constants of R_1C_1 and R_2C_2 should correspond to a frequency much lower than the frequency to be passed by the amplifier. A time constant of 0.1 second was found to be satisfactory in discriminating out a 60-cps signal from the envelope of the second harmonic.

Values of C_3 and C_4 are equal and their time constant individually in connection with resistor R_3 should correspond to a frequency of thirty cycles. The value of C_5 is found by experiment. In combination with the inductance presented by T_1 it reshapes the output signals of the transformer to the closest approximation of a sine wave that conditions permit.

Amplifier Operation

If the output signal of the bridge to the amplifier is as shown in Fig. 3A, then the output of tube V_1 acting as an amplifier is an amplified replica of the signal at the input to the grid of the following tube V_2. This is indicated by Fig. 3B.

The output of V_2 appearing across R_3 in the absence of the integrating capacitor, C_4, is as shown at Fig. 3C. This signal may have almost exactly rectangular waveform as indicated since the tips of the positive peaks are flattened by grid current into the high-resistance grid circuit. Also, the small portion of the waveform between cut-off bias and zero bias intercepted on the transfer characteristic of the tube has its curved sides straightened by the curvature of the characteristic.

The introduction of the integrating capacitor, C_4, changes the vertical edges of the rectangular pulses to exponential type curves. This is shown by the difference between the dashed lines and the solid curved lines in Fig. 3D. The combined effect of C_5 and the inductance of T_1 are shown by the approximate sine waves of Fig. 3E as they finish the reshaping of the pulses into a motor-operating signal of greater efficiency. This signal has its phase directly related to the higher peaks of the second harmonic signal. In this manner the bridge output phase relationship is maintained so as to provide directional response of the

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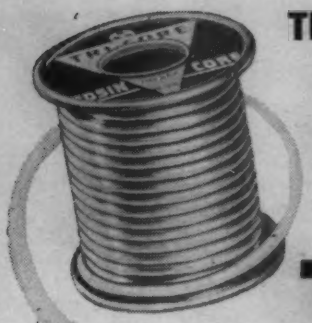

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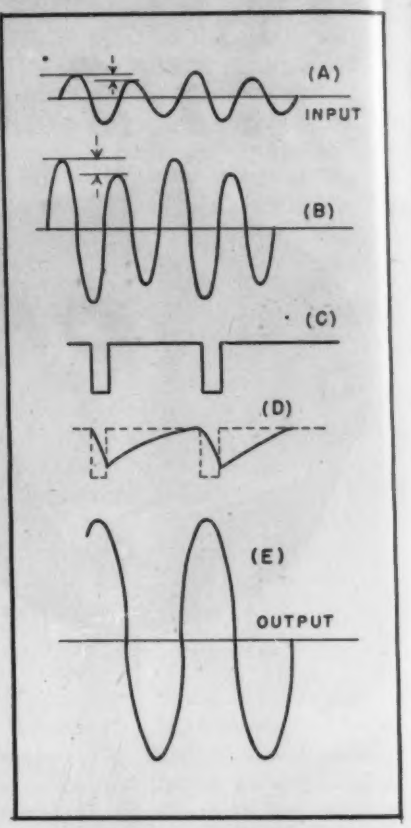

FIG. 3—Bridge signals of slight unbalance indication passing through the discriminator amplifier to be discriminated into a signal of complete unbalance

drag cup motor to the direction of bridge unbalance.

Advantages

From the change in the output to input signal waveform of Fig. 3, it will be noted that only a slight bridge unbalance is needed to give the identical change of signal arrived at through complete bridge unbalance as shown in Fig. 1. Although straight amplification of the null signal along with automatic control of amplifier gain might give almost equivalent results, if the unwanted harmonic signals are first removed, there are other important advantages of this system that make it very desirable.

If a measure of the sensitivity of the bridge circuit is assumed to be in the displacement of the bridge variable necessary to change the output signal from a complete null for the fundamental frequency, while the harmonics are present at a maximum, to the condition where the fundamental is a maximum and no harmonics are present, then, amplification of the bridge output signal is obtained in terms of a small-

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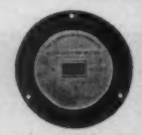

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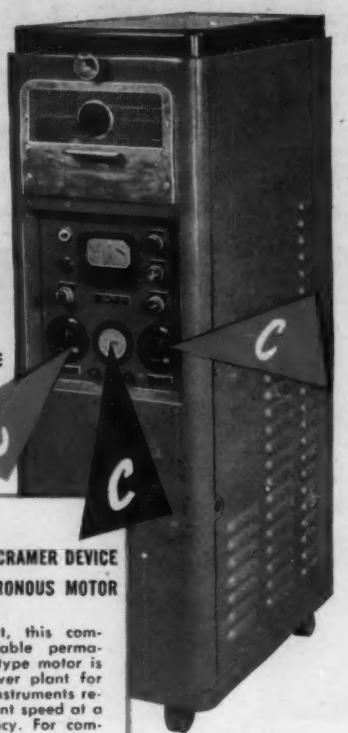

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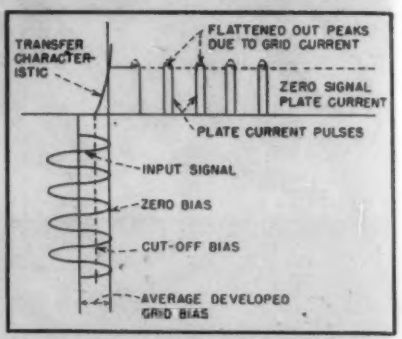

FIG. 4—Discriminator action allowing input frequency to pass through amplifier

er displacement producing a given change of signal. Or in other words, the Q of the bridge is increased.

The circuit automatically introduces gain control in that the grid bias continually adjusts itself to signal levels. Final maximum output is soon reached with a small input signal and overloading of the output does not occur on larger signals. But perhaps the greatest good is achieved because the tips of the peaks of waveforms of radically different shapes can be somewhat depended upon to produce pulses in the discriminator plate circuit of the same phase and shapes. Hence, a certain amount of flexibility is added to the servo-system in allowing the input to the amplifier to operate at different levels of signal distortion.

Discriminator Action

The dynamic transfer characteristic of the discriminator tube is shown in Fig. 4 and 5 to clarify the separation of signals by this action. In Fig. 4, the peaks of the incoming signal are all of equal amplitude. These peaks manage to maintain the grid bias sufficiently low enough to permit the positive tips to just exceed zero bias and

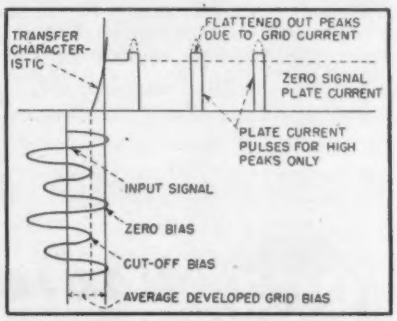

FIG. 5—Discriminator action allowing only input frequency of highest peaks to pass through amplifier

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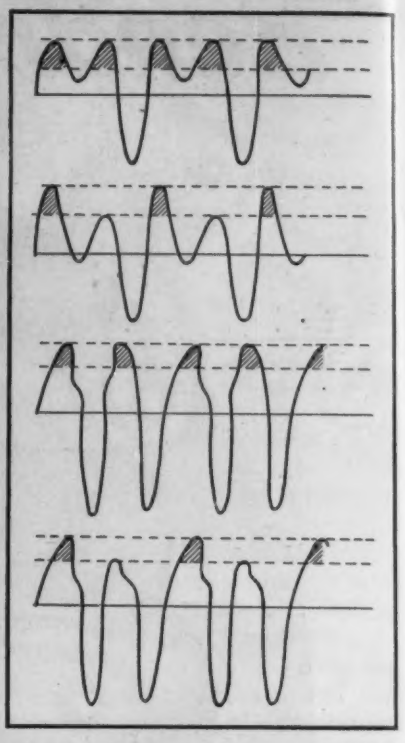

FIG. 6—Different waveforms react the same to discrimination producing almost identical pulses

se draw grid current to recharge the grid circuit negatively. Only that portion of the waveform projecting above the cut-off bias is capable of influencing the plate current of the tube.

In Fig. 5, the positive peaks of the signal alternate in amplitude. If the lower peaks are below cut-off bias they have no effect upon plate current. The higher peaks manage to exceed the zero bias value and draw grid current to maintain an average grid bias proportional to their amplitude. In this case the frequency of the output plate current pulses corresponds to the frequency of the fundamental modulating the envelope of the second harmonic, and no second harmonic is present in the output since there are no plate current pulses to represent it.

The smaller the percentage of the signal amplitude that corresponds to five volts the sooner the early stages of bridge unbalance indication can be completely amplitude discriminated. With the circuit shown it was possible to cause all vestige of second harmonic to disappear and the fundamental to become a maximum with one twentieth of the former required pri-

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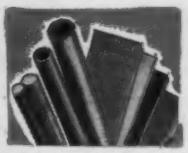

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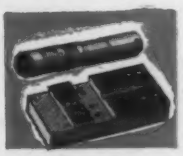

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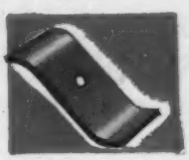

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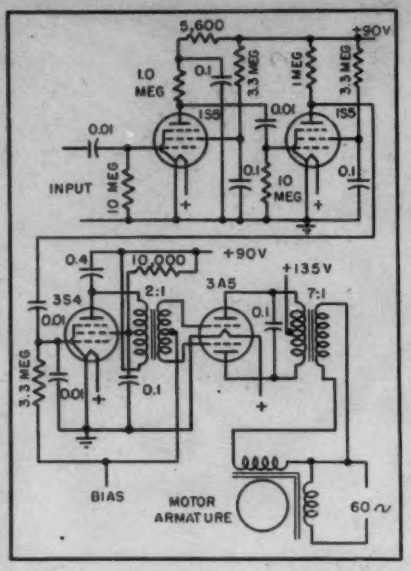

FIG. 7—Experimental circuit of amplifier for portable use

mary control displacement at the bridge input.

Stray 60-cycle pickup was not the nuisance under this system that it was under ordinary voltage amplification. Such pickup did not modulate the second harmonic nor could it otherwise interfere with the higher level grid signals put into use by this method.

Radically different waveshapes may give fundamentally the same output pulses in the discriminator plate circuit. The curves that are shown in Fig. 6 show how this may be possible. Those parts of the curves between the two lines representing cut-off bias and zero bias determine the frequency of the output pulses. The tips of such wave variations are very similar in shape and become even more so in the plate circuit of the discriminator as they draw grid current and are altered by curvature of the transfer characteristic.

In Fig. 7 an experimental circuit for adaptation to portable use is given with the values for circuit components. Only the amplifier unit alone is shown since the input and output controls are part of other developments.

To one accustomed to thinking of amplification strictly in terms of actual amplitude or power increase, it is surprising to see the output signal anticipate the input signal in changing its waveform while no apparent change occurs in the input.

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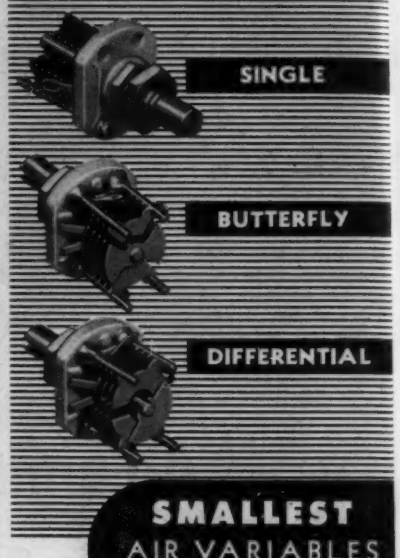

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BUTTERFLY TYPE — Applicable wherever a small split stator tuning condenser is required. Available in four models: 1.72 to 3.30 mmf, 2.10 to 5.27 mmf, 2.72 to 8.50 mmf, and 3.20 to 11.02 mmf.

DIFFERENTIAL TYPE—For switching capacity from rotor to either of two stators, and for shifting tap on capacity divider. Available in four models: 1.84 to 5.58 mmf, 1.98 to 9.30 mmf, 2.32 to 14.82 mmf, and 2.67 to 19.30 mmf.

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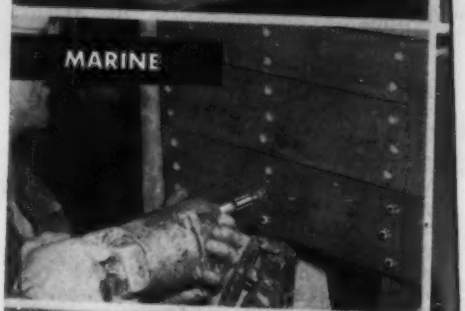

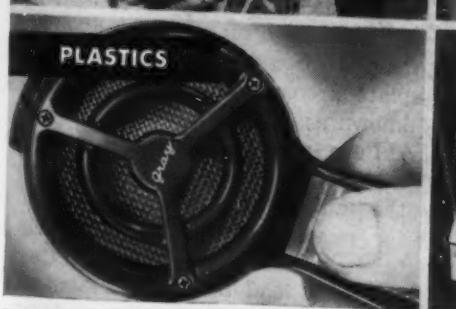

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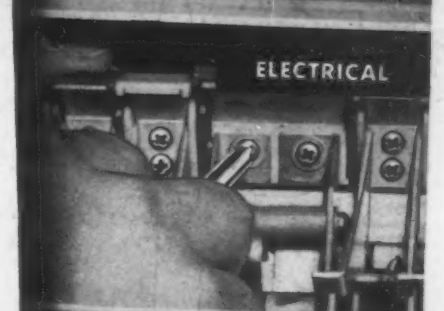
For example, virtually the entire automobile industry has standardized on Phillips Screws—lists them in their Standards Book. Similarly, Phillips Screws are standard in most of the largest aircraft plants. Manufacturers of every type of screw-fastened assembly, large and small, use Phillips Screws exclusively.

Such universal acceptance by industry is the best possible evidence that Phillips Screws alone have *all* the qualifications essential to a *standard* cross recessed head screw. For unequalled mechanical advantages, for dependable uniformity, for unlimited supply potential, for universal acceptance, you can depend on PHILLIPS.



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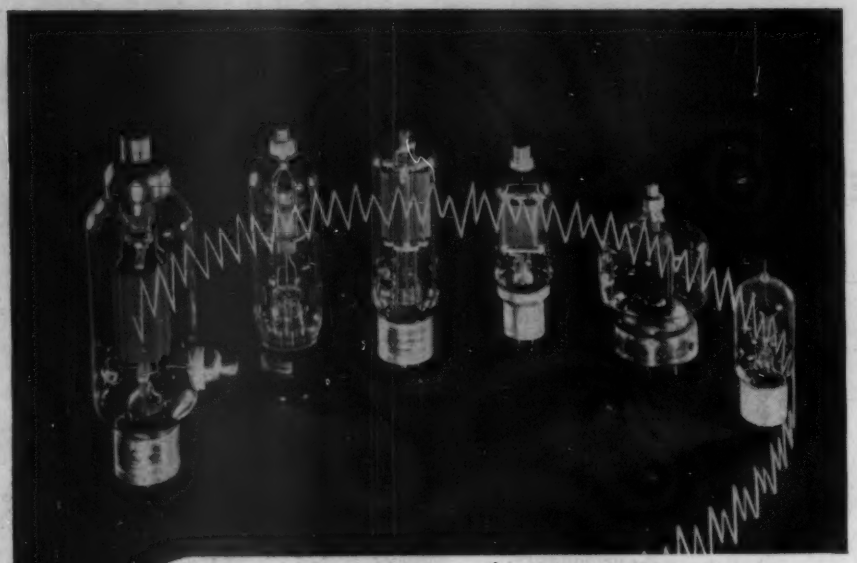

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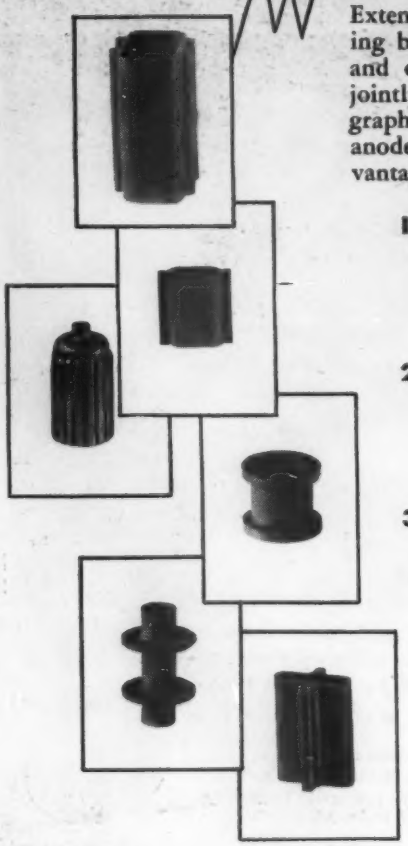

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THE ELECTRON ART

(continued from p 130)

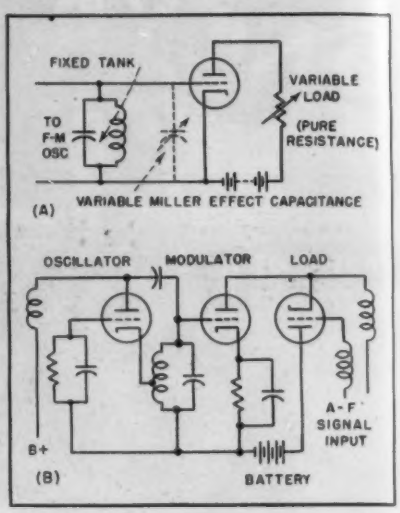

FIG. 1—(A) Basic principle of Miller effect frequency modulator circuit depends on variation of load resistance of tube reflecting a variable capacitance across its input. In practical adaptation of this principle (B) modulator tube is placed across oscillator and has a vacuum tube for load

cuit shows that, in the general case, the input admittance between grid and cathode has both real and imaginary components. But if the load is purely resistive, as in this special case, and the grid-plate and grid-cathode capacitances are of the same order of magnitude and the product of frequency, grid-plate capacitance, plate resistance and load resistance is considerably less than unity, the input becomes purely capacitive. This input capacitance is equal to $C_{GK} + C_{GP}(1 + A)$, and its dependence on the amplification factor of the tube and plate circuit conditions is familarly known as the Miller effect.

Pure negative (capacitive) reactance can thus be injected into the tank circuit without the need for phasing circuits or multigrid tubes; the only requirement is that the plate load be purely resistive. To produce the frequency modulation, the gain A of the tube is varied by the additional elements shown at Fig. 1B. The amplification of the modulator tube is varied by placing in its plate circuit another tube as load which behaves as a variable resistance dependent on the audio-frequency signal voltage. The oscillator tube is connected in a Hartley circuit.

Because both cathode and grid of the load tube operate at r-f potentials, it is necessary to use

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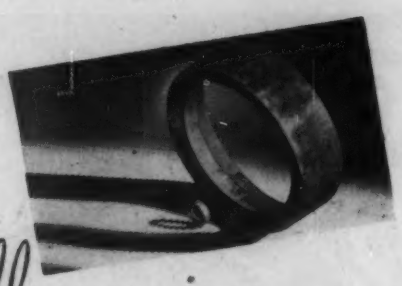

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r-f chokes to separate the r-f and a-f portions of the circuit. The battery provides the proper bias for maximum linearity between a-f input, internal resistance of the load tube, and frequency deviation

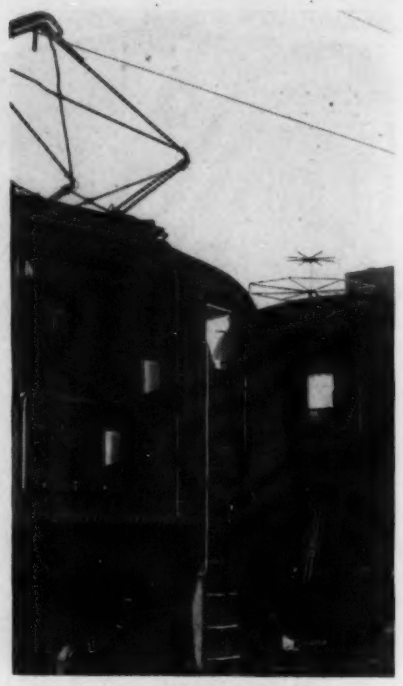

FIG. 2—Frequency modulation radiotelephone train antenna was located near locomotive to create most adverse noise problem for purposes of testing

of the oscillator. Drift of the oscillator's center frequency is easily counteracted by superimposing a compensating voltage obtained by usual automatic frequency control techniques on the battery voltage. Although the frequency stability of this circuit is inherently comparable to that of all direct f-m circuits, the simplicity of this circuit reduces the difficulties of stabilizing frequency. Of course, the frequency of the oscillator can be stabilized by a quartz crystal, in which case the Miller effect modulator can produce phase modulation, which can be used directly or fed to multiplier stages.

Experiments with Radiophone

This new modulator circuit has been used in equipment built for the Italian State Railways to determine the feasibility of very high frequency radiotelephone communications between a moving train and a fixed ground station. Troubles from microphonics en-

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counted with reactance-tube modulators were eliminated by using the Miller effect modulator and frequency stability was better. These tests were made on carrier frequencies around 110 mc with 40 watts output from the transmitters. For tests the antenna train was purposely placed coach next to the electric motive, as shown in Fig. 2. The trified sections of the right-of use 3,000-volt overhead line train is drawn by a 3,000 hp locomotive.

The transmitter consisted of a Miller effect modulator using a 12J5GT and a 12AH7GT, a 12A6 oscillator multiplier, 12A6 frequency doubler, 832 frequency tripler, and 829B power amplifier. A total frequency multiplication of 18 is obtained to produce a modulation index of 4, which is sufficient to give suitable noise suppression despite the adverse antenna location and the change in signal strength because of the cuts and built-up suburban districts through which the 24 miles of track between Rome and Tivoli pass.

Repeated tests on this line have consistantly indicated the possibility of establishing satisfactory commercial quality radiophone communication between the moving train and a fixed station at Rome with the exception of those places where the line enters tunnels of considerable length near Tivoli.

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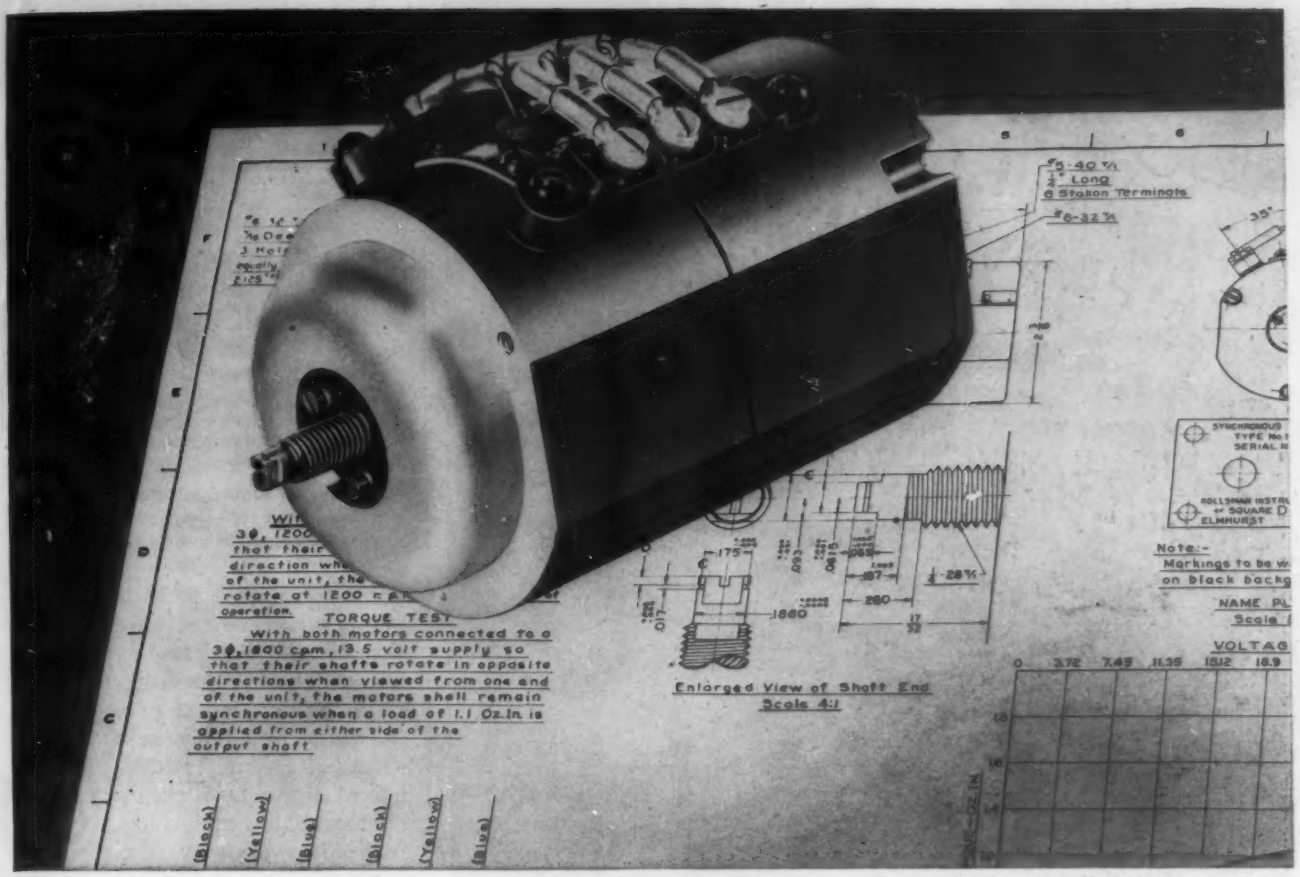
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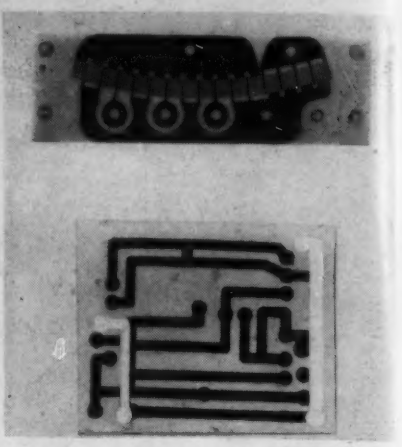

A commutator formed in ceramic and a circuit formed on top and bottom of a thin, transparent plastic sheet

patterns because it is basically a photographic reproduction method. Commercial photographic materials usable in this process are capable of resolving lines less than 0.0005 inch in width which are separated by spaces of the same width. This inherent dimensional accuracy of the photographic material may be realized in accuracy of circuits or other patterns reproduced by the method.

Description of the Process

The first steps in the process are merely the following of the standard procedure of photography: printing opaque and transparent copies either by contact or by optical projection (at any desired reduction ratio) onto a commercial silver halide emulsion. This emulsion may be coated either as a photographic plate or film. Following exposure, the image is developed in the conventional manner, resulting in the reduction of the silver halide to metallic silver particles imbedded in the gelatine. These silver particles, because they are buffered by nonconductive gelatine do not form a conductive layer. In fact, the resistance of the conventional photographic image area is of the same order of magnitude as that of the nonimage area.

The next step in the process is one of physical replacement of the image areas by other materials. Silver, carbon, graphite, or other substances obtainable in finely divided powder form can be used. By this replacement the original base material, glass or film, bears a

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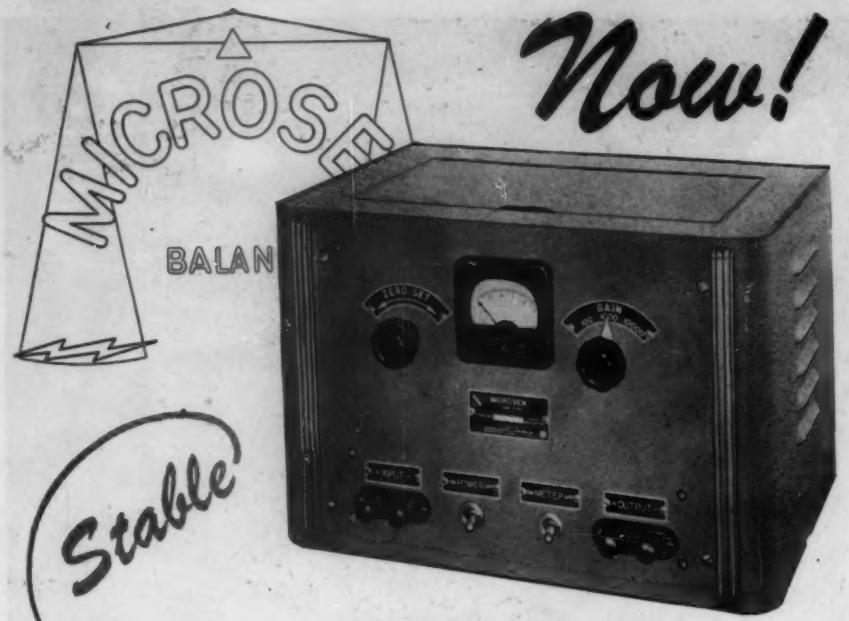

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faithful and strongly adhering replica of the original image in relief. The definition of detail in this new pattern is influenced only by the photographic image definition and the fineness of the powder used in the replacement step. At this point in the process, the pattern, if it is conductive, can be electroplated to build any desired thickness.

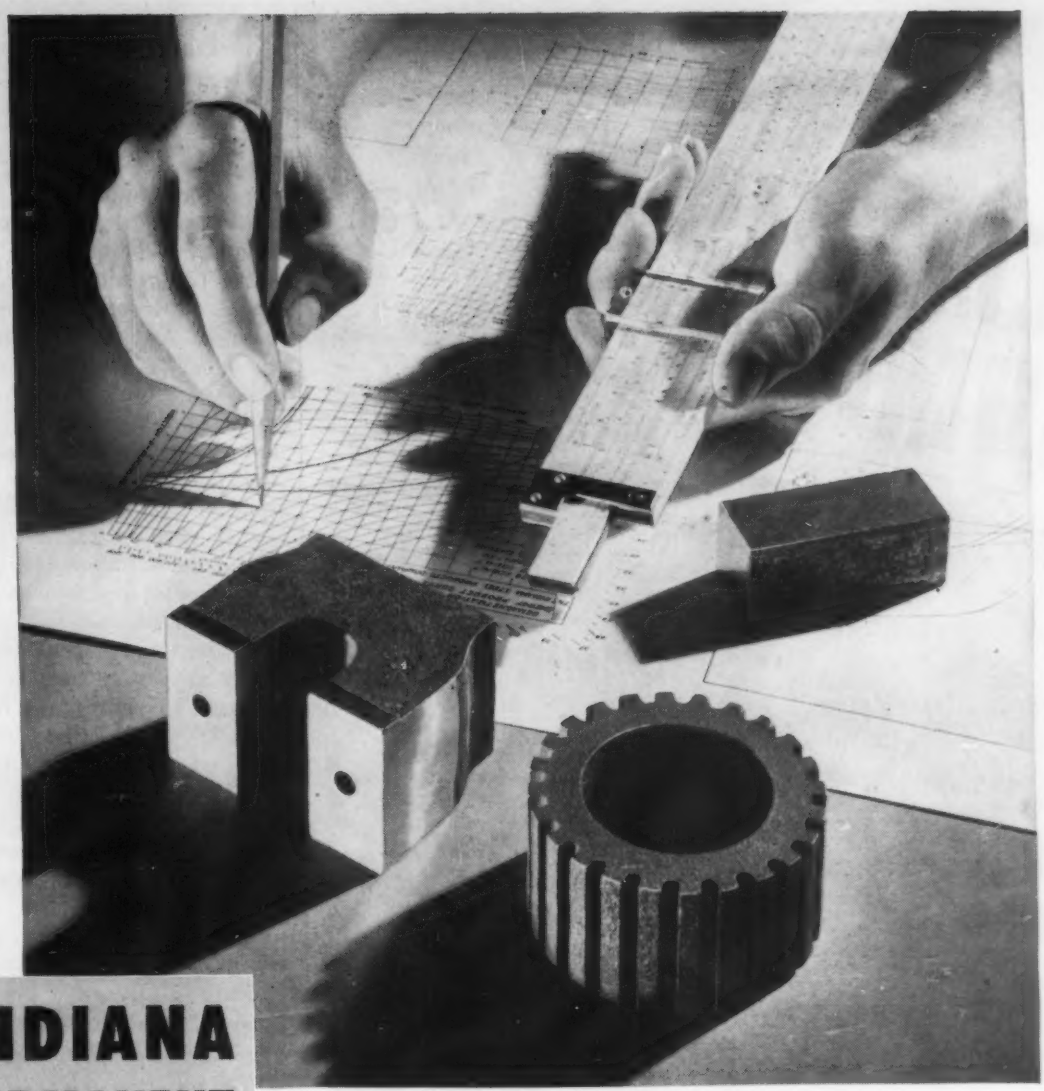
Because the original base, film or plate, is usually mechanically or electrically unsuitable for the ultimate use of the circuit or pattern, a final step is usually required. The entire pattern is transferred to a new base material. Several different types of transfer material are possible. It may be a thermoplastic or thermosetting resin or a ceramic.

Most experience has been with transfer to a thermosetting polyester resin. The resin may be clear or mixed with a filler such as asbestos fiber. To accomplish the transfer step, the image-bearing film is placed face upwards on a flat or curved plate. A hollow rectangle of polyvinyl-alcohol sheeting is placed around the part to serve as a dam for the viscous casting resin, and the polyester co-polymer with a slight amount of added catalyst is poured over the surface. The material, while in its viscous state, fills the interstices between the pattern segments. After the resin sets, the pattern becomes mechanically imbedded and probably chemically bonded to the polyester resin.

As a final step, the casting is lifted from the base plate and the original film base is removed with a differential solvent which leaves the resin base untouched. The pattern surface is then flush with the base surface in which it is imbedded.

Aside from the obvious applications of the described technique to the now conventional printed circuit production, it is possible that other uses may occur to the engineer. There may be, for instance, some applications in the scientific instrument and optical fields.

A few of the applications that have been considered are: (1) formation of complicated conductive patterns to be used as commutators, (2) making tapered re-



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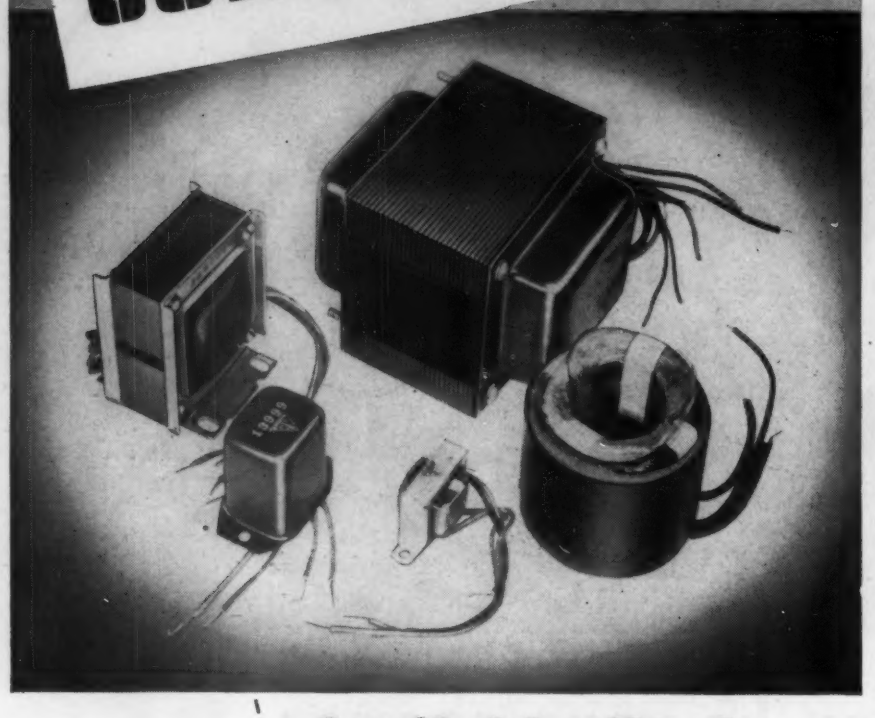

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sistors of any complex function for resistance pots in computor systems. (3) making durable and decorative nameplates and dials for instruments, (4) making grid patterns for radioactivity and x-ray screens, using lead, gold or the new Hevimet alloy as the powdered metal, (5) making thermocouple or thermistor-bolometer elementary mosaics, and (6) production of optical grids of greater durability and stability than photographic grids. The first two applications require smoothness durability of the conductive coatings to withstand the action of a moving stylus. Tests have been carried up to several hundred thousand actuations of a rheostat stylus over such surfaces with success.

A dividend of the method, not stressed in the above description, is economy on short runs made possible by lowered (almost negligible) tool costs. Practically the only expense in changing from one part to another or from one circuit configuration to an entirely different one is the draftman's work of drawing new copy.

Photographic illustration of the results of this process are not particularly informative because the finished product looks like the original drawing. The accompanying photograph serves chiefly to indicate the type of circuits than can be rendered in this medium. The author expresses his gratitude for the cooperation and support of the Squier Laboratory of the Signal Corps in the pursuit of this project.

The Synchrostrob Timer

By WALTER R. BERG

Ordnance Research Laboratory
The Pennsylvania State College
State College, Pennsylvania
(Now with Dictograph Products, Inc.
Jamaica, N. Y.)

IN VIEWING rotating machines by standard stroboscopic methods constant manipulation of the light source frequency is necessary in order to prevent the stroboscopic image from changing position. Furthermore, it is practically impossible to orient the image to a specified angular position manually. The circuit shown in Fig. 1 automatically holds the stroboscopic image at a

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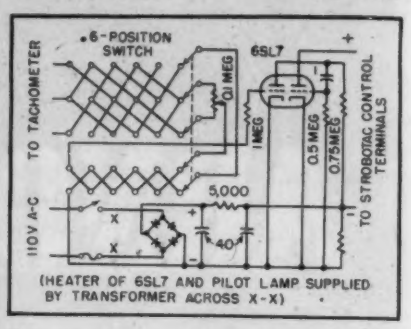

FIG. 1—Circuit diagram of synchronizer that provides phase adjustment throughout 360 degrees

fixed angular position over wide variations in the speed of the rotating member. By means of coarse and fine phase shift controls the stroboscopic image can be held in any position over the entire 360 degrees.

A three-phase generator must be coupled to the shaft of the rotating member. The coarse phase shift, which is a six-position switch, selects each of the generator's three phases at 0 or 180 degrees, which affords a total variation of 360 degrees in six discrete steps of 60 degrees each. The fine phase shift control is a potentiometer which allows complete phase variation over any 60-degree step. By means of a double triode the voltage from the phase shift network is half-wave grid rectified, amplified, and clipped. The resulting wave form has the steep wave front that is necessary to trigger most types of stroboscopic circuits.

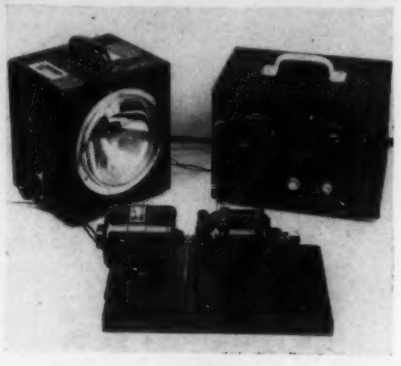

FIG. 2—The Synchrostrob is used with a tachometer and a Strobotac to observe rotating machinery

The Synchrostrob was designed to trigger the contactor input of a General Radio Strobotac which, in turn, can be used to trigger a General Radio Strobotron if greater light intensities are desired. Other

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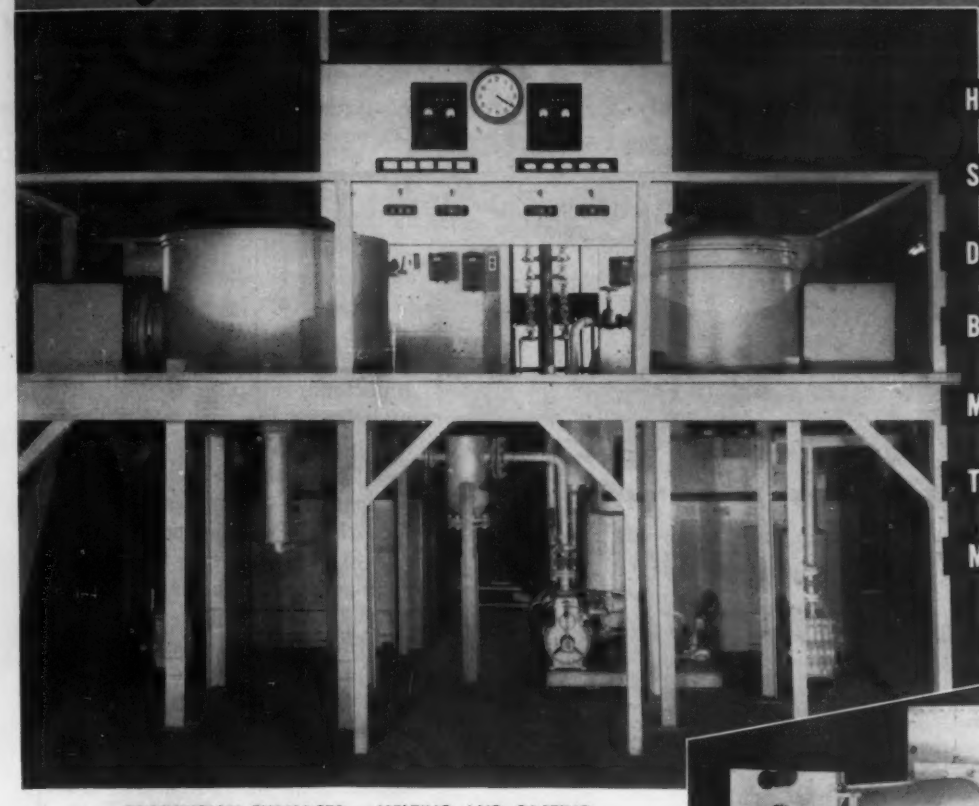

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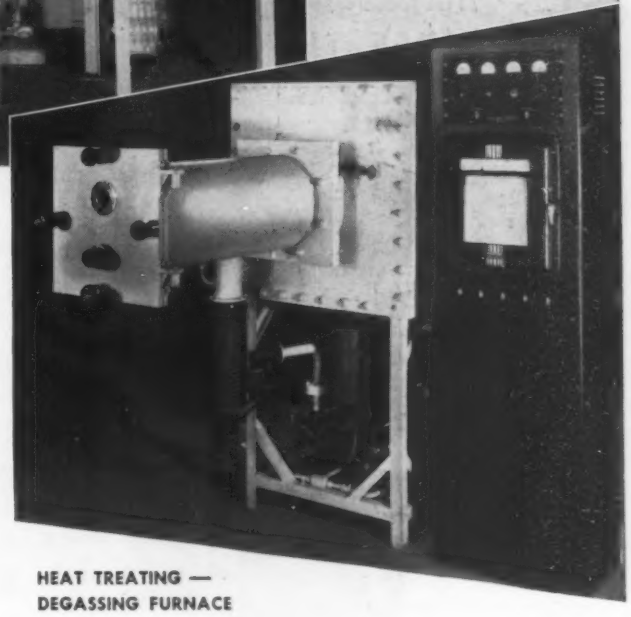

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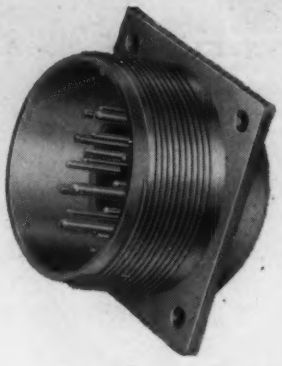

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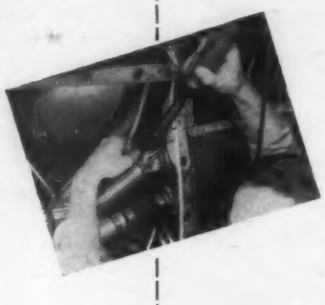

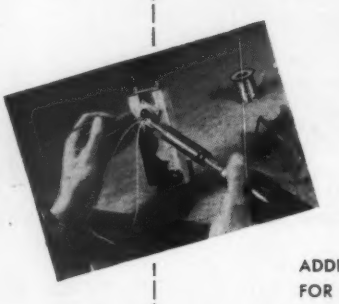

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types of stroboscopic light sources can also be triggered with this circuit.

SURVEY OF NEW TECHNIQUES

TRACERS FOR INDUSTRIAL RESEARCH are being used in a large scale experiment conducted in the Cleveland plant of Republic Steel Corp. by Arthur D. Little Inc. Although 75 percent of radioactive tracers are still used in biological work, this industrial study is indicative of the potentiality of tracer technology in other fields. The experiment was conducted to determine methods for keeping undesirable sulfur out of steel. Sulfur enters steel from the coke, with the ore, limestone, scrap, or fuel oil. Some of it leaves the furnace in slag and flue gases. To tell where the sulfur in the finished steel came from, radioactive sulfur was introduced into the coke. The portion of sulfur in the finished steel that was radioactive was then known to have come from the coke. In this manner the contributions made by the various sources can be assessed. The tests indicated that there is no advantage in buying low sulfur coal from which to make the coke. Other applications of radioactive tracers in industry include automatically controlling Bessemer converters by introducing a known percent of radioactive phosphorus and metering the process to determine when the proper grade steel had been obtained. The major advantage of radioactive tracer research in industrial plants is that the experiments are carried out in the plant at operating scale; small scale laboratory experiments do not always correlate with factory results.

SYNTHETIC MICA, known as fluorine-phlogopite mica, has the desirable characteristics of muscovite and phlogopite forms of natural mica and is suitable for use as insulator and dielectric. Inherent in the synthetic process is the possibility that further research may reveal ways of directly fabricating mica components. The research and development program for the production of synthetic mica, jointly sponsored now by the Office of Naval

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√**FREQUENCY CONTROL:** main dial true logarithmic scale 12 inches long. Frequency-increment dial calibrated from +50 to —50 cycles.

√**FREQUENCY CALIBRATION:** can be standardized within 1 cycle at any time by setting instrument to line frequency or zero beat.

√**ZERO BEAT INDICATOR:** neon lamp for zero beat at line frequency or zero scale.

√**FREQUENCY STABILITY:** drift from cold start less than 7 cycles in first hour and completed in 2 hours.

√**OUTPUT INPEDANCE:** 600 ohms, either grounded or balanced-to-ground, and essentially constant at all output voltages.

√**OUTPUT VOLTAGE:** approximately 25 volts open circuit. For matched resistive load voltage varies less than ±0.25 db between 20 and 20,000 cycles.

√**OUTPUT CONTROL:** calibrated from +25 db to —20 db referred to 1 milliwatt into 600 ohms.

THE Type 913-A Beat-Frequency Oscillator, introduced by General Radio in 1942 immediately set a standard of excellence because of its high frequency stability, low distortion and constant output. Since then two improved models have increased its utility and acceptance.

The new Type 1304-A Oscillator is so different from the original that it is essentially a new instrument with many refinements in the circuit, in the oscillator, addition of buffer amplifiers, improved mixer and new amplifier. It is the finest beat-frequency oscillator obtainable.

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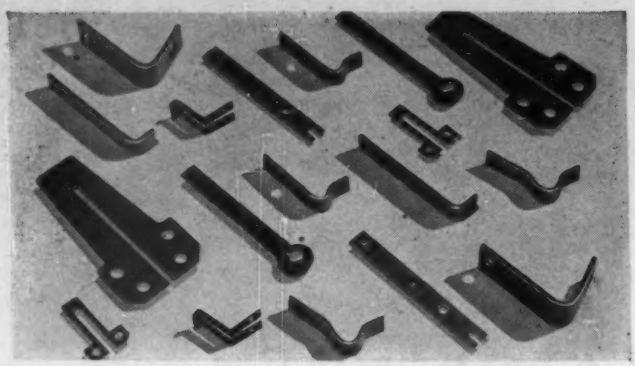

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				500° F.	25
	A	560			
				70° F.	20
	B	78,000,000	Resistivity at	300° F.	25 ohms (cir. mil-ft.)
				500° F.	32
	C	.00091			
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INFRARED SPECTROSCOPY has been simplified by the development of a method for growing large crystals containing 42 percent thallium bromide and 58 percent thallium iodide by Francis Phelps and of polishing the soft semiplastic crystals by Edgar Robertson, both of the National Bureau of Standards. The prism so made has the large index of refraction of 2.6 in the visible region and 2.2 at 40 microns. The refraction changes greatly with temperature. This new prism extends the observable range to 40 microns (potassium bromide crystals permitted observation only to about 24 microns). Investigations in this unexplored region have already shown polystyrene and polyethylene to be very transparent and that many compounds containing chlorine, bromine, and sulfur have bands in this region.

EXPERIMENTS in pulse code modulation can be readily carried out by a technique developed by D. B. Smith working under Prof. W. H. Radford at MIT. In place of the pulse coding tube developed by Bell Labs. (ELECTRONICS, p 126, Dec., 1947), a conventional cathode-ray tube can be used to code the signal. A coding mask, cut the same as the aperture plate, is placed in front of the cathode-ray tube screen. A phototube receives coded impulses of light as the beam sweeps across the screen at levels determined by the instantaneous sampled amplitude of the signal. With this relatively simple apparatus one can study pulse code modulation systems. At MIT the equipment is being used to investigate the trans-

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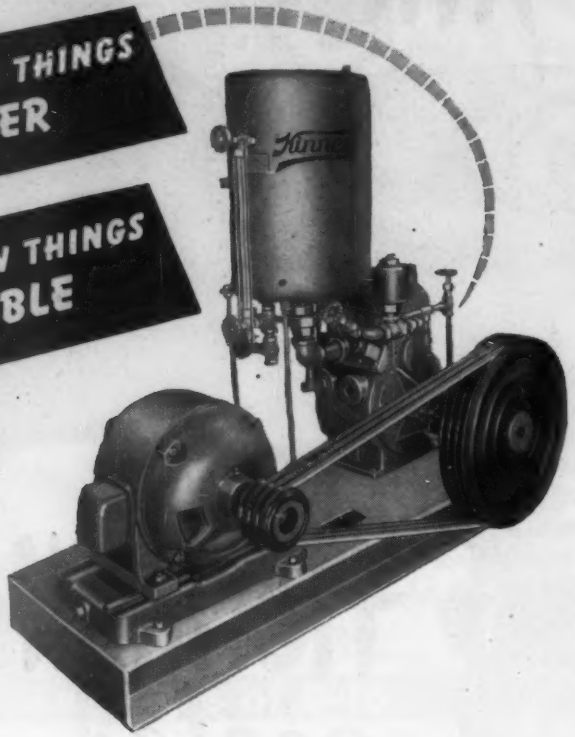

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CORONA at high altitude can be suppressed, in the case of ceramic bushings and other insulations upon which are imposed high potential gradients, by application of a semiconducting coating to the entire exposed insulation surfaces. The technique may be applied to such high-voltage equipment as radar and is particularly advantageous when used on airborne electronic equipment where space and weight must be held to a minimum. Coating solder-seal bushings of hermetically sealed components with material having a surface resistivity of about 3,000 megohms per square inch sufficiently distributes voltage stress to increase the high altitude a-c corona starting voltage by 200 percent or more and the average flashover voltage by 120 percent; d-c corona and flashover points are raised 70 percent. Similar improvements are produced on bushings at sea level. The magnitude of the resistivity of the semiconducting coating is such that there would be no serious current drain on actual electronic equipment treated in this manner.

Methods of detecting inception of corona, measurements of improvements obtained, and an analysis of electrostatic field configurations in the vicinity of a typical bushing have been described in High Altitude Flashover and Corona Correction on Small Ceamic Bushings, by W. W. Pendleton, *A.I.E.E. Proc.*, 1947.

HIGHEST POWERED MAGNETRON developed so far for microwaves produces 50 kilowatts at 1,000 megacycles (1 kmc). Unlike most conventional tubes, the cathode is unheated, emission being produced by cathode bombardment with high-speed electrons each one of which releases three or four secondary electrons. The water-cooled tube was developed by the General Electric Research Laboratory under Signal Corps contract. Dr. R. B. Nelson, G. E. scientist, told a group of vacuum tube researchers convened at Ithaca in June that the limit to the power that can be produced at this high frequency is not yet in sight.

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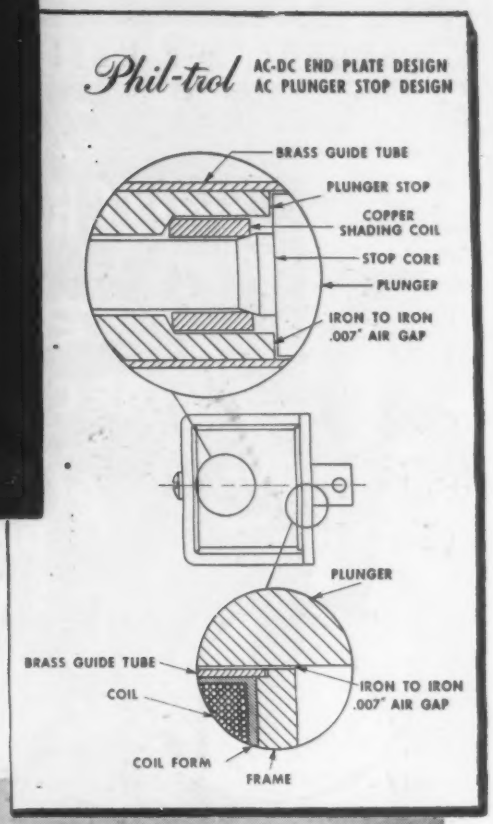

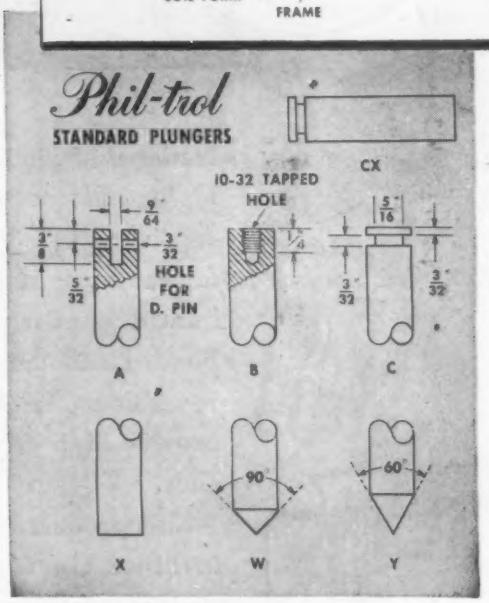

Type 27

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There is a complete line of Phil-trol Relays, all engineered to the highest standards, for electronic and industrial control, signal and traffic control, radio, communication, aircraft and other applications. Send for new Relay Catalog.

Phil-trol PRODUCTS

Relays, Actuators, Solenoids, Contactors, Starting Switches, Focus Coils, Ion Traps and Special Process Control Assemblies.

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PRODUCT OF NATIONAL RESEARCH

National
SWITCH INSULATION

PHENOLITE

Remarkable
ARC RESISTANCE
plus
DIMENSIONAL
STABILITY

(PHENOLITE CORE)
(FIBRE SURFACES)

National Switch Insulation is a highly efficient "sandwich" material consisting of a Phenolite core—for dimensional stability even under humid conditions—permanently bonded and molded with Peerless Insulation (Fish Paper) surfaces, to provide high arc (tracking) resistance.

This product is used effectively to insulate electrical switches and equipment where high dimensional stability and arc resistance are required in proximity to current-carrying components.

For full details call or write

NATIONAL VULCANIZED FIBRE CO.
WILMINGTON 99, DELAWARE
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scope, picture generator, and distribution panel is available in combination or separately. The equipment produces synchronizing, driving, and blanking signals useful to manufacturers of television receivers. Two monographs giving further details have been published.

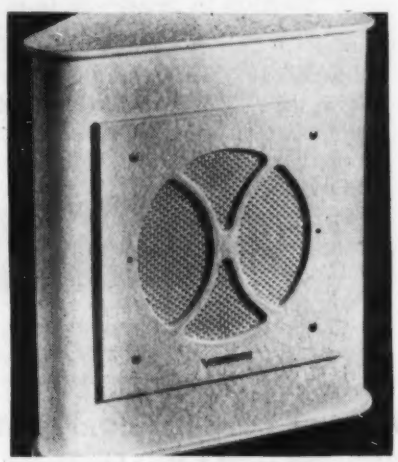
Pilot Light

DIAL LIGHT CO. OF AMERICA, INC., 900 Broadway, New York 3, N. Y. Designed particularly for use with the NE-51 neon lamp, the new Multivue cap refracts light in such a

way as to improve effectiveness of the low-wattage neon lamp in pilot light service.

Loudspeaker Baffle

VIBRALOC MFG. CO., 3597 Mission St., San Francisco, Calif. The new general purpose loudspeaker baffle with Acousticurve design is adaptable to table, wall, or corner mounting. It may be had in a variety of



PLASTICON CAPACITORS

HI VOLT POWER SUPPLIES

Designed to transform 118 VAC to high voltage—low current DC for use in radiation counters, oscilloscopes, dust precipitators, projection television sets, spectographic analysers, photoflash equipment, etc. Hi Volt Power Supplies are self-contained in hermetically sealed steel containers.

HIVOLT

Cat. No.	VDC	Dimensions	Your Cost
PS-1	2400	3¹⁄₁₆x3¾x5½"	$11.14
PS-2	2400	3¹⁄₁₆x3¾x5½"	15.14
PS-5	5000	4¹⁄₁₆x3¾x6½"	38.22
PS-10	10000	4¹⁄₁₆x3¾x8"	58.80
PS-30	30000	7x7x7"	147.00

PHOTOFLASH CAPACITORS

For the best in photoflash capacitors, specify PLASTICONS for faster discharge and more light. Type AOCOE are the lightest photoflash capacitors made, more flexible to use, safer and more economical than single high capacitance large block.

PHOTO FLASH

Cat. No.	Watt Sec.	Pk. Chg V.	Dimensions	Your Cost
AOCOE22C3	7.6	2250	4x2x1¼"	$2.92
AOCOE3M2	9	3000	4x2x1¼"	3.00
AOCOE4M1.5	12	4000	4x2x1¼"	3.20
AOCOE55C1	15.1	5500	4x2x1¼"	3.56
AOCE4M12	100	4000	4½x4¹⁄₁₆x3¾	27.17
AOCE4M24	200	4000	8x4¹⁄₁₆x3¾"	38.81

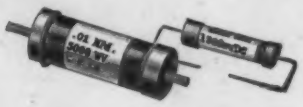
PLASTICONS

By the use of synthetic plastic film dielectrics, PLASTICONS can be made smaller, lighter, more efficient and more economical than older types of capacitors made with paper and mica insulation. Plasticon films are chemically purer and more uniform. Plasticon capacitors have a longer life and can operate under more severe conditions.

SPECIAL PLASTICONS

Taking advantage of the wide variety of plastic film dielectric characteristics, Plasticons are engineered to meet many special applications. We can furnish capacitors for 200°C; for pulse network duty; close tolerances; ultra high resistance. Send us your specifications.

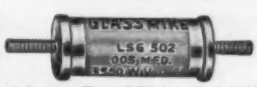
GLASSMIKES ASG



Type ASG are Plasticon A dielectric-silicone fluid impregnated capacitor elements in hermetically sealed glass tubes. Temperature range — 60° C to + 125° C. The smallest and lightest high voltage capacitors made. Type ASG are ideal for DC and low frequency AC applications.

Cat. No.	Cap. Mfd.	Volts D.C.	Dimensions	Your Cost
ASG 1	.01	600	¹⁹⁄₆₄x1⅛"	$ .88
ASG 2	.02	600	¹⁹⁄₆₄x1⅛"	.94
ASG 3	.05	600	¹⁹⁄₆₄x1⅛"	1.03
ASG 4	.1	600	⅜x1⅛"	1.15
ASG 5	.25	600	³⁵⁄₆₄x2¼"	1.32
ASG 6	.5	600	1⅜x2¾"	1.53
ASG 7	.005	1,000	¹⁹⁄₆₄x1⅛"	.88
ASG 8	.01	1,000	¹⁹⁄₆₄x1⅛"	.94
ASG 9	.02	1,000	¹⁹⁄₆₄x1⅛"	1.00
ASG 10	.05	1,000	¾x1¾"	1.09
ASG 11	.1	1,000	¾x2¼"	1.26
ASG 12	.25	1,000	³⁵⁄₆₄x2¾"	1.47
ASG 13	.002	2,000	¹⁹⁄₆₄x1⅛"	1.12
ASG 14	.005	2,000	¹⁹⁄₆₄x1⅛"	1.21
ASG 15	.01	2,000	¹⁹⁄₆₄x1⅛"	1.32
ASG 16	.02	2,000	¹⁹⁄₆₄x1⅛"	1.47
ASG 17	.05	2,000	¾x1¾"	1.66
ASG 18	.1	2,000	³⁵⁄₆₄x2¼"	1.88
ASG 19	.25	2,000	1⅜x2¾"	2.18
ASG 20	.001	3,000	¹⁹⁄₆₄x1⅛"	3.03
ASG 21	.002	3,000	¹⁹⁄₆₄x1⅛"	3.09
ASG 22	.005	3,000	¹⁹⁄₆₄x1⅛"	3.18
ASG 23	.01	3,000	¹⁹⁄₆₄x1⅛"	3.28
ASG 24	.02	3,000	¾x1¾"	3.44
ASG 25	.05	3,000	³⁵⁄₆₄x2¼"	3.62
ASG 26	.1	3,000	1⅜x2¾"	3.82
ASG 27	.001	5,000	¹⁹⁄₆₄x1⅛"	3.82
ASG 28	.002	5,000	¹⁹⁄₆₄x1⅛"	3.94
ASG 29	.005	5,000	¹⁹⁄₆₄x1⅛"	4.09
ASG 30	.01	5,000	¾x1¾"	4.26
ASG 31	.02	5,000	¾x2¼"	4.50
ASG 32	.05	5,000	1⅜x2¾"	4.79
ASG 33	.1	5,000	1⅜x3½"	5.35
ASG 34	.001	7,500	¹⁹⁄₆₄x1⅛"	4.12
ASG 35	.002	7,500	¹⁹⁄₆₄x1⅛"	4.26
ASG 36	.005	7,500	¾x1¾"	4.44
ASG 37	.01	7,500	¾x2¼"	4.79
ASG 38	.02	7,500	³⁵⁄₆₄x2¾"	5.44
ASG 39	.05	7,500	1⅜x2¾"	6.76
ASG 40	.0005	10,000	¹⁹⁄₆₄x1⅛"	4.29
ASG 41	.001	10,000	¹⁹⁄₆₄x1⅛"	4.41
ASG 42	.002	10,000	¹⁹⁄₆₄x1⅛"	4.59
ASG 43	.005	10,000	¾x1¾"	5.29
ASG 44	.01	10,000	³⁵⁄₆₄x2¼"	6.17
ASG 45	.02	10,000	1⅜x2¾"	7.35
ASG 46	.03	10,000	1⅜x3½"	8.82
ASG 60	.06	10,000	1⅜x3½"	10.29
ASG 47	.0005	15,000	³⁵⁄₆₄x2¾"	8.53
ASG 48	.001	15,000	³⁵⁄₆₄x2¾"	8.70
ASG 49	.002	15,000	1⅜x2¾"	9.12
ASG 50	.0005	20,000	1⅜x3½"	11.47
ASG 51	.001	20,000	1⅜x3½"	12.05
ASG 52	.0005	30,000	1⅜x3½"	13.24

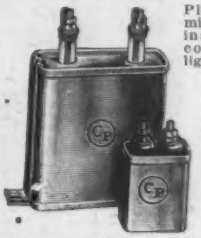
RF GLASSMIKES



Plasticon L film-silicone fluid impregnant in Glassmike style case. Type LSG has Q of 2500 to 5000. Rated at 3500 WV—7500 V Test. Lower losses, more easily mounted, smaller and more economical than mica capacitors.

Cat. No.	Cap. Mfd.	Dimensions OD Length	Your Cost
LSG500	.00005	¹⁹⁄₆₄x1⅛"	$.88
LSG101	.0001	¹⁹⁄₆₄x1⅛"	.88
LSG251	.00025	¹⁹⁄₆₄x1⅛"	.88
LSG501	.0005	¹⁹⁄₆₄x1⅛"	.88
LSG102	.001	¹⁹⁄₆₄x1⅛"	1.00
LSG202	.002	¾x1⅛"	1.44
LSG502	.005	¾x1¾"	2.06
LSG602	.006	¹⁹⁄₆₄x1⅛"	2.20
LSG103	.01	¹⁹⁄₆₄x1¾"	2.50

INDUSTRIAL and TRANSMITTING



Plasticon A element, mineral oil impregnated in sturdy lead coated steel containers. Smaller, lighter and more economical than paper capacitors. Temperature range — 40°C to +105°C. Type AOC-rectangular; Type AOCO-flattened oval.

Type ASC and ASCO (not listed) have Plasticon A element, silicone impregnated. Same dimensions as corresponding AO types. Temperature range — 60° C to + 125° C; greater capacitance stability. Prices on application.

DC RECTANGULARS

Cat. No.	Cap. Mfd.	Volts DC	Dimensions	Your Cost
AOC6C1	1.0	600	2⅛ 1¾ 1"	$2.19
AOC6C2	2.0	600	2⅛ 1¾ 1"	2.65
AOC6C4	4.0	600	3½ 2½ 1⅛"	3.30
AOC6C8	8.0	600	4 3¾ 1¼"	4.98
AOC6C10	10.0	600	4⅛ 3¾ 1¼"	5.60
AOC1M1	1.0	1,000	2⅛ 1¾ 1"	2.37
AOC1M2	2.0	1,000	4 1¾ 1"	3.17
AOC1M4	4.0	1,000	4 2½ 1⅛"	3.85
AOC1M8	8.0	1,000	4⅛ 3¾ 1¾"	5.43
AOC1M10	10.0	1,000	4⅛ 3¾ 1¾"	6.27
AOC2MO5	0.5	2,000	2⅛ 1¾ 1"	2.84
AOC2M1	1.0	2,000	3½ 1¾ 1"	3.47
AOC2M2	2.0	2,000	3½ 2½ 1⅛"	4.02
AOC2M4	4.0	2,000	3½ 3¾ 1¾"	5.43
AOC3M1	1.0	3,000	4 2½ 1⅛"	7.12
AOC3M2	2.0	3,000	4 3¾ 1¼"	9.05
AOC3M4	4.0	3,000	4⅛ 3¾ 2¼"	12.52
AOC4M1	1.0	4,000	4 3¾ 1¼"	16.17
AOC4M2	2.0	4,000	4 3¾ 1¾"	19.40
AOC4M4	4.0	4,000	4 3¾ 4¹⁄₁₆"	29.64
AOC5M1	1.0	5,000	4 3¾ 1¾"	19.40
AOC5M2	2.0	5,000	3½ 3¾ 4¹⁄₁₆"	24.25
AOC75C1	1.0	7,500	3½ 3¾ 4¹⁄₁₆"	29.11
AOC10M1	1.0	10,000	4 3¾ 4¹⁄₁₆"	51.74

DC OVALS

Cat. No.	Cap. Mfd.	Volts D.C.	Dimensions	Your Cost
AOCO6C2	2.0	600	2⅛ 2 1¼"	$2.59
AOCO6C4	4.0	600	4 2 1¼"	3.11
AOCO1M1	1.0	1,000	2⅛ 2 1¼"	2.26
AOCO1M2	2.0	1,000	3½ 2 1¼"	3.04
AOCO3MO1	0.1	3,000	2⅛ 2 1¼"	4.46
AOCO5MO1	0.1	5,000	2¾ 2 1¼"	8.28
AOCO5MO25	0.25	5,000	3½ 2 1¼"	9.05
AOCO5MO5	0.5	5,000	4⅛ 2 1¼"	10.68
AOCO8MOO5	0.05	8,000	2¾ 2 1¼"	8.93
AOCO8MO1	0.1	8,000	3½ 2 1¼"	9.83
AOCO1OMOO5	0.05	10,000	3½ 2 1¼"	11.32

LABORATORY CAPACITORS

Type LAG (Glassmike style) and Type LAC (Rectangular can) have the lowest dielectric absorption of any capacitor made. Residual charge is .01 — .02%. Dissipation factor at 1 MC is .0002 to .0003. Capacitance and Q is constant from DC to 100 KC. Resistance averages one million megohms per microfarad. Standard capacitance tolerance is ± 5%. Type LA units are used for timing and integrating circuits.

Cat. No.	Cap. Mfd.	Dimensions	Your Cost
LAG101	.0001	¹⁹⁄₆₄x1⅛"	$1.76
LAG201	.0002	¹⁹⁄₆₄x1⅛"	1.76
LAG501	.0005	¹⁹⁄₆₄x1⅛"	1.76
LAG102	.001	¹⁹⁄₆₄x1⅛"	1.76
LAG202	.002	¹⁹⁄₆₄x1⅛"	2.06
LAG502	.005	¾x1¾"	2.88
LAG103	.01	¾x1¾"	3.94
LAG203	.02	¾x2¼"	5.12
LAG503	.05	³⁵⁄₆₄x2¼"	6.17
LAC104	.1	2¼x1¼x1"	9.23
LAC204	.2	2¼x2½x1³⁄₁₆"	9.82
LAC504	.5	4x2½x1³⁄₁₆"	12.35
LAC105	1.	4x3¾x1¼"	18.87
LAC205	2.	4x3¾x2¼"	30.16
LAC505	5.	6x3¾x4¹⁄₁₆"	57.98

The above condensed version of the Plasticon Line will appear in the new catalogs of leading electronic distributors. Plasticons are manufactured by Condenser Products Company, Chicago 22, Illinois

For PERFORMANCE That Is *Precisely Predictable*

Special purpose transformers which meet the most rigid specifications are a Raytheon specialty. What more exacting test can you imagine than wartime service in naval SG and SO radar . . . *for which Raytheon Transformers were used exclusively?*

Raytheon can furnish custom-engineered transformers designed to fit *your* special needs . . . in the size, type and quantity you require. As one of the oldest and largest producers, Raytheon has the experience and facilities to design, test and deliver transformers that you can incorporate in your product or equipment with complete confidence.

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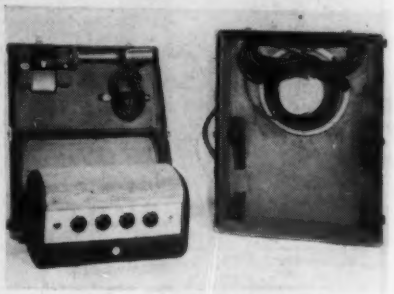
. . . and VOLTAGE STABILIZERS

Bulletin DL-V-304 tells the complete story on the new line of high performance, space and weight saving Raytheon Voltage Stabilizers. Write for it today.

sizes and finishes. A catalog sheet is available.

Portable Sound System

RADIO CORP. OF AMERICA, Camden, N. J. Type SP-15A portable sound system consists of an aerodynamic mike, a high-output amplifier and a



heavy-duty alnico permanent magnet speaker. It operates on 100-watt, 50 to 60-cycle power supply. Complete system weighs 45 pounds.

Tube Base Diagrams

RADIO CORP. OF AMERICA, Camden, N. J. The new Triple Pindex is actually three separate booklets in one spiral-bound cover, permitting instant location and simultaneous

study of any three tube base diagrams from over 475 types. Listings are arranged in dictionary fashion. Price is 75c from distributors.

Industrial Rectifier

NATIONAL ELECTRONICS, INC., Batavia Ave., Geneva, Ill. Type NL-649 is a 2-ampere, single-ended industrial rectifier tube. It is mercury vapor filled permitting a peak inverse voltage rating of 900 volts and can be used in 250-volt d-c ap-

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FL-33 PICKUP
FOR COLUMBIA MICROGROOVE RECORDS

Astatic takes extreme pride in presenting its PICKUP for use with the sensational new Columbia LP Records. This is not just another version of what related equipment for Microgroove Records should be—but the actual playing arm designed to meet the precise requirements of Columbia's new recordings. The new pickup is manufactured to meet the specifications by Columbia to insure maximum quality performance of the Columbia LP Microgroove Record. Available, then, in the Astatic FL-33 Pickup and LP-33 Crystal Cartridge, is the ultimate of Microgroove companion equipment. Here is the professional playing arm, and its replacement cartridge, alone capable of getting the most out of LP Records. And that "most" is truly incomparable—a reality, depth and clarity of tone, a flawless fidelity of reproduction never before obtainable from commercial records.

FEATURES OF ASTATIC'S FL-33 PICKUP—THE PERFECT COMPANION FOR COLUMBIA LP RECORDS

1. Five-Gram Needle Pressure, of prime importance with the new, lower-radius needle tip. 2. Permanent Sapphire Needle with .001" Tip Radius. 3. Approximately One-Half Volt Output. 4. Frequency Range 30 to 10,000 c.p.s. 5. Novel Design at Base Eliminates Tone Arm Resonances and Assures Perfect Tracking. 6. LP-33 Cartridge, with Permanent Sapphire Needle, instantly replaceable in FL-33 Pickup on slip-in principle of modern fountain pen. "LP" means long playing, low pressure.

ALSO AVAILABLE is the LP-78 Cartridge that fits the FL Arm, but having a .003" radius needle; thereby, playing 78 RPM Records. By merely slipping in either cartridge you have the proper pickup for 78 or 33-1/3 Records.

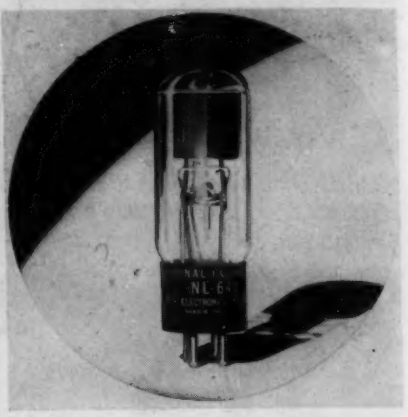
FL FILTER

An important accessory that goes hand-in-glove with Astatic's FL-33 Pickup, for best performance with high quality speakers, is the FL Filter. Controls pickup response—Eliminates high frequency peak.

THE Astatic CORPORATION
ASTATIC
CONNEAUT, OHIO
IN CANADA: CANADIAN ASTATIC LTD., TORONTO, ONTARIO

Listed in the Radio Industry Red Book

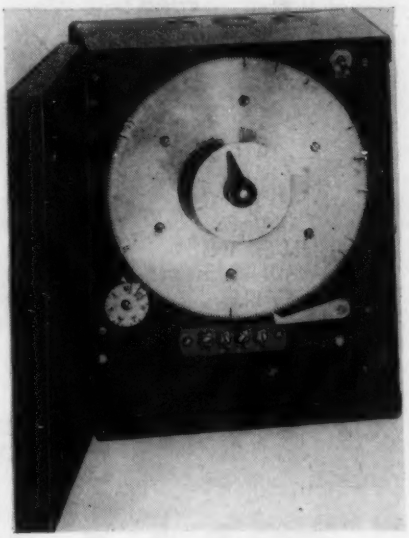
Astatic Crystal Devices Manufactured Under Brush Development Co. Patents



plications. Filament voltage is 2.5; filament current, 7 amp; d-c output, 2 amp; peak-current output, 10 amperes.

Industrial Timers

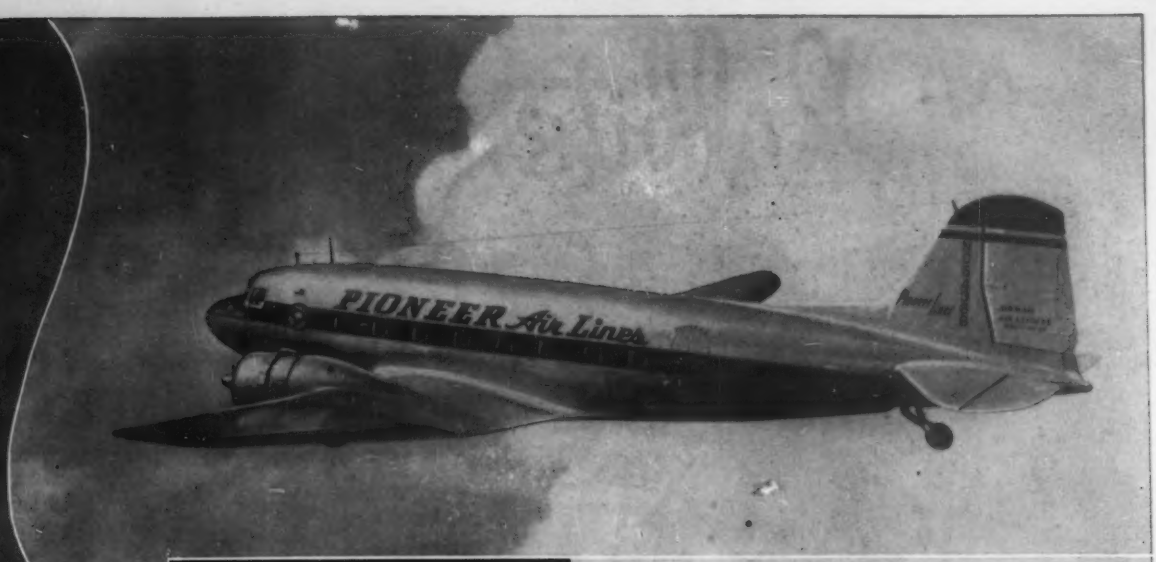
MONTGOMERY MFG. CO., 549 W. Washington Blvd., Chicago 6, Ill., has introduced two synchronous program timers, models TP and TS, designed especially for manufacturing establishments where permanent conduit or BX installations in standard switch box cases are desired. Model TP, for bell ring-



ing, can make a single circuit contact at any 5-minute interval in 24 hours and repeat each day. Model TS incorporates a holding circuit which it closes on the first impulse and opens on the succeeding impulse.

Radio Noise Filters

THE FILTRON CO., 38-25 Bell Blvd., Bayside, L. I., N. Y. Type FA204



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PIONEER EQUIPS GROUND *STATIONS WITH Wilcox Type 378A Package Radio

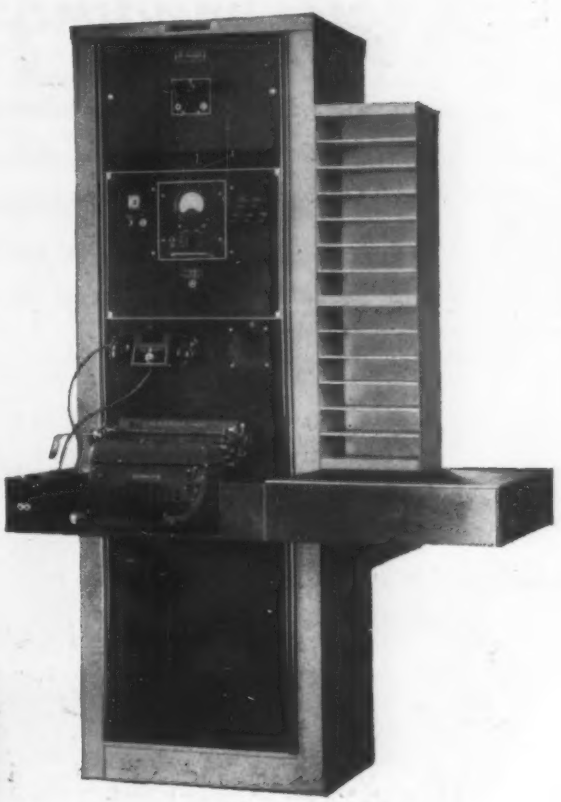
PACKAGE DESIGN SPEEDS YOUR INSTALLATIONS
The Type 378A is *complete* from microphone to antenna, ready for connection to power mains. It is designed for aeronautical VHF ground-air communications at smaller traffic centers.

PROVEN COMPONENTS INSURE QUALITY AND PERFORMANCE—The Type 305A VHF Receiver and Type 364A VHF Transmitter (50 watts) are the principal components of the 378A. Long used separately and field-tested by leading airlines, these units are now available in package form.

NEW AIDS TO CONVENIENT OPERATION
The telephone handset with its convenient push-to-talk button, serves as both headphone and microphone, with an auxiliary loudspeaker for incoming calls. The 378A includes desk front, message rack, and typewriter space—there are no accessories to be added.

LOCAL OR REMOTE CONTROL—If desired, the control panel can be removed and the 378A remotely controlled, either by re-installing the panel at the operating position or by simple adaptation to your existing control equipment.

**Pioneer aircraft are also 100% equipped with the new WILCOX Type 361A Airborne VHF Communication System.*



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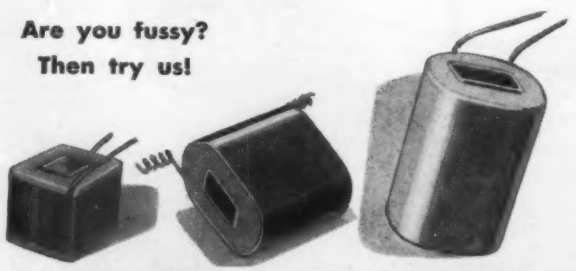
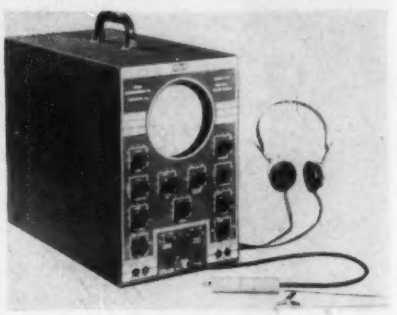


COTO-COIL CO., INC.
COIL SPECIALISTS SINCE 1917
65 Pavilion Ave., Providence 5, R. I.

radio interference filter is but one of a wide variety of Filtrons for suppression of noise. Featured are high attenuation, small size, light weight, and hermetic sealing. Rating of the unit illustrated is 2.5 amperes, 50 volts d-c.

C-R Stethoscope

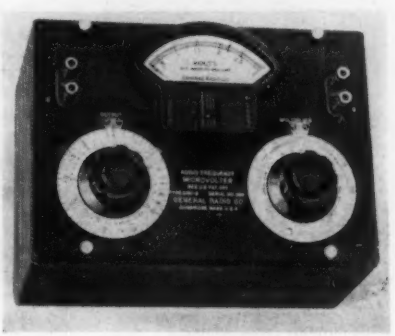
FEILER ENGINEERING CO., 947 George St., Chicago, Ill. The new five-inch cathode-ray oscilloscope combined with stethoscope is designed for f-m and television serv-



icing. It can also be used for a-m and audio work. Price is $89.95 list.

A-F Microvolter

GENERAL RADIO CO., 275 Massachusetts Ave., Cambridge 39, Mass. Type 546-C Microvolter represents a redesign to standardize its output level at 600 ohms. Sensitivity, frequency response, and distortion



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RESISTORS FOR SPECIAL APPLICATIONS made to order. I-T-E Power Resistors are made with a normal tolerance of 10%. Tolerances of 5% and less are made to order.

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Type	Watts	Length	Maximum Recommended Resistance	Mounting Centers
108 Oval	30	1¼"	10000	2"
200 Oval	40	2"	15000	2¾"
316 Oval	55	3½"	25000	4¼"
424 Oval	65	4¾"	35000	5½"
600 Oval	75	6"	50000	6¾"

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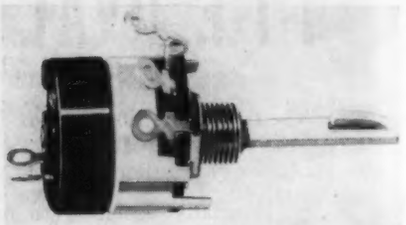
characteristics have also been improved. Output voltage range is 0.1 microvolt to 1.0 volt open circuit for an input of 2.2 volts across 600 ohms. Accuracy is ± (3 percent + 0.5 μv) for output levels above 1 microvolt at frequencies below 20,000 cycles. Up to 100,000 cycles the accuracy is ± 5 percent. Distortion introduced by the instrument is about 0.2 percent.

Variable Resistor

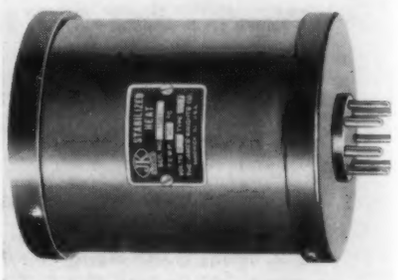
P. R. MALLORY & CO., INC., Indianapolis, Indiana. The new Midgetrol measures 15/16 inch and has a number of other features such as a



flat shaft, or a special phenolic shaft for television applications. Specification sheets and a descriptive folder are available.

Crystal Oven

JAMES KNIGHTS CO., Sandwich, Ill. A new crystal oven recommended for broadcast or standard frequency applications has a large 7-pin base,

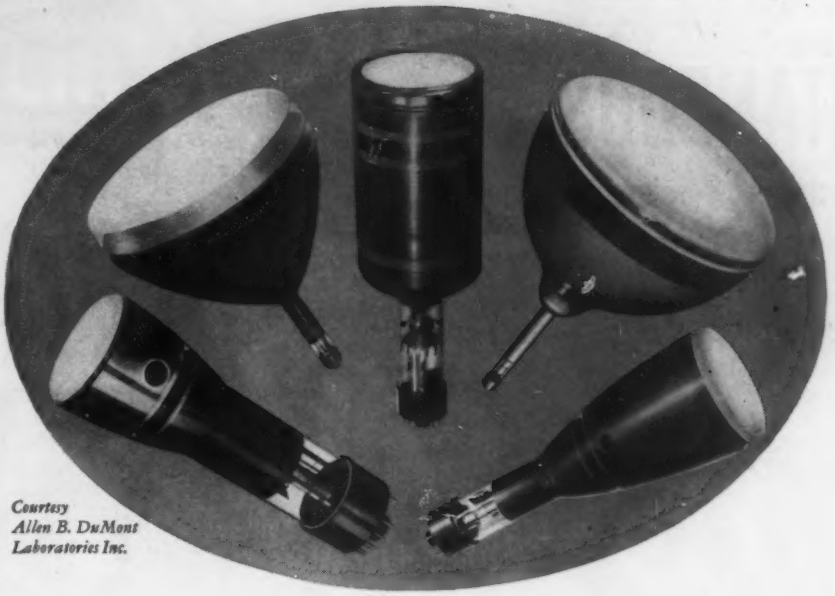


6.3-volt heater, and operating temperature 50± 1 C. The crystals are electrostatically shielded.

Pressure Element

COMMERCIAL RESEARCH LABORATORIES, INC., 20 Bartlett Ave., Detroit 3, Mich. A new Type 5 direct pressure element replaces type 3 pressure element and type 3 gas sampling valve. Owing to the new design, the element is open for less

The *NEW* "dag" CRT Wall Coating ...



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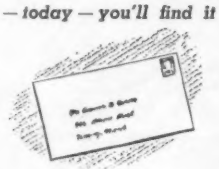

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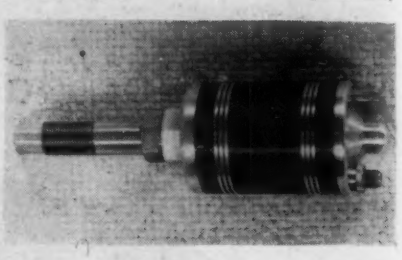

than 0.001 second permitting its use in tests on high-speed engines over the whole engine cycle.

Television Capacitors

SPRAGUE ELECTRIC CO., North Adams, Mass. A new line of capacitors designed for television serv-

ice is rated at 85 C up to 450 volts. Shelf life of these electrolytic units has been improved.

LP Needles

ELECTROVOX CO., INC., 66 Franklin St., East Orange, N. J. Microgroove needles of sapphire and osmium

alloy needed for the new long playing records are available in two styles illustrated.

Signal Generator

FERRIS INSTRUMENT CO., Boonton, N. J. Model 24-B a-m and f-m signal generator provides frequencies from 5 to 220 mc with either internal or external modulation. It is designed primarily for production checking f-m and television receivers. Any seven spot frequencies in the range are available with an

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Complete terminal equipment occupies a double cabinet 7′ wide x 2′ 4″ deep x 6′ 6″ high, and aerials may be up to 100′ away from the equipment.

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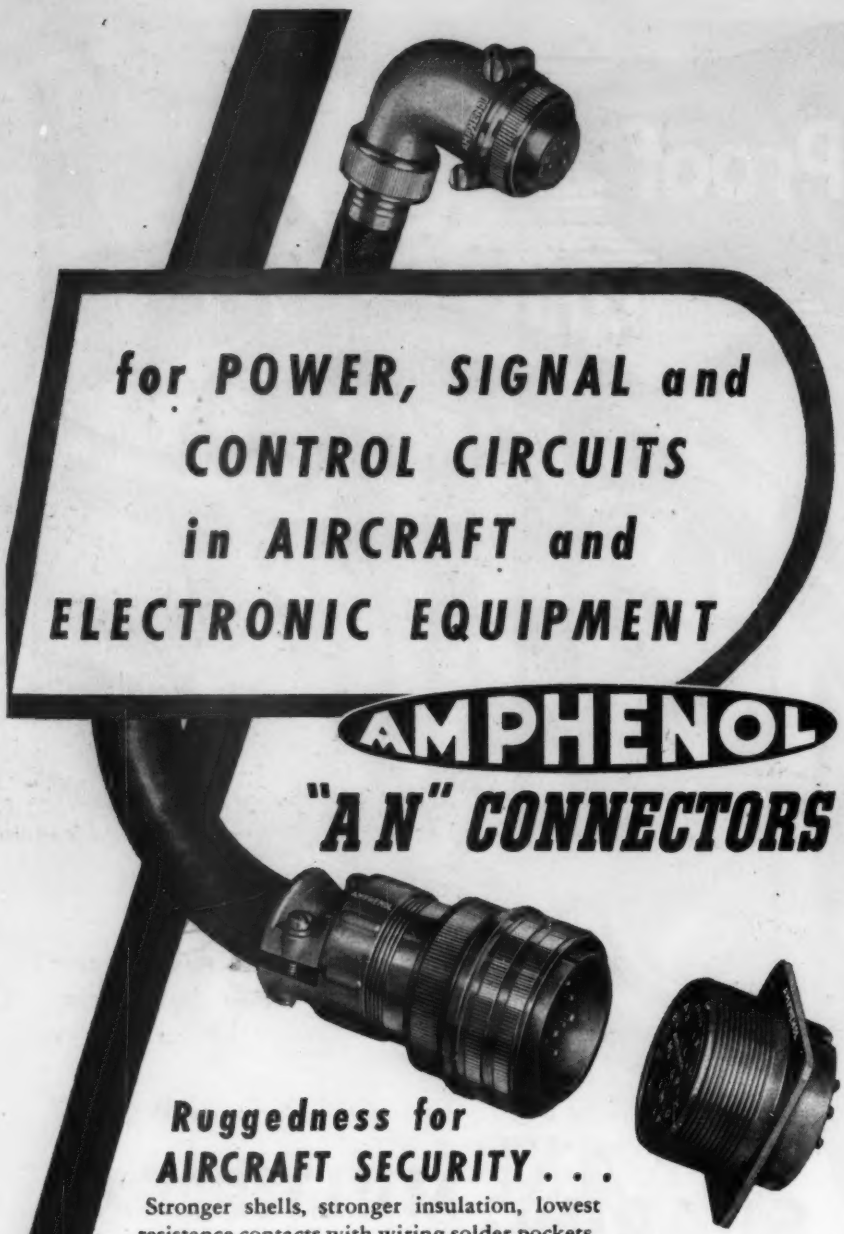

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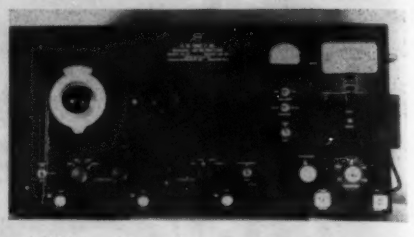
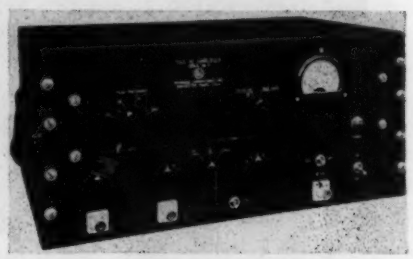


additional number by changing coil drums. The instrument has a built-in power supply. Details of the various features are available.

Special Amplifier

BROWNING LABORATORIES, INC., Winchester, Mass. Amplifier TAA-16 is used in the determination of voltage standing wave ratio when used with square law detector probes and slotted waveguides. Two inputs are available. Operations can



be wide band or highly selective as needed. There is an integral power supply, electronically regulated. Full-scale meter readings are obtained with 15 microvolts input under wide band operation.

Isolation Transformer

RADIO CORP. OF AMERICA, Camden, N. J. The type WP-24A Isotap variable-voltage isolation transformer has been designed for speedy receiver servicing. Choice of test voltages provided consists of 117-

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THE pinch hitter who swats the ball over the heads of the outfielders for a homer has "the *extra something* that spells top performance."

In any field it's the *extra something* that makes top performance possible.

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Plate Height	1"	1"	1 3/16"	1 1/2"	1 1/2"
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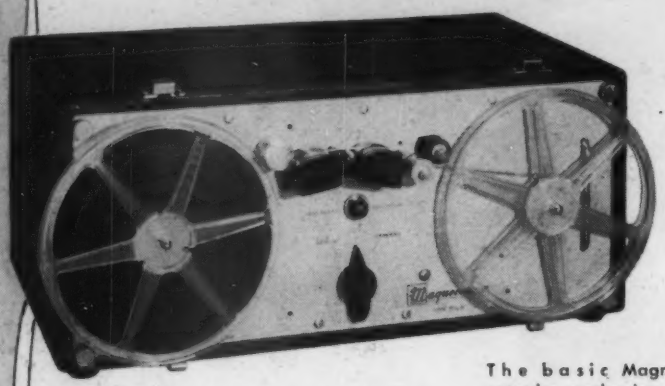

The basic Magnecorder recorder mechanism (PT6-A)

The New 3 Element

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Reels — Standard 7-inch 8MM film reels.
Current failure never throws tape. Instantly interchangeable from portable to rack mounting.

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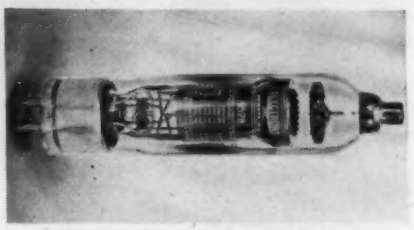
volt normal supply, 105-volt low supply or 130-volt high supply, under medium-load conditions. The instrument also gives protection against shocks from a-c and d-c chassis to ground and prevents damage to test equipment.

Grid-Controlled Rectifier

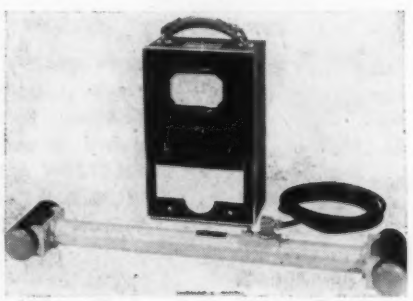
ELECTRONS, INC., 127 Sussex Ave., Newark, N. J. announce development of the type 5528 (C6L) temperature-free grid-controlled rectifier tube designed especially for high power servomotor control or



inverter applications which must operate at up to 800 cycles. It features 60 second heating time, a peak inverse voltage of 500 v, 6.4 amperes steady d-c current, and 77 amperes peak.

Magnetometers

THOMAS E. SMITH, 122 East 42nd St., New York 17, N. Y. Presence and polarity of magnetic fields can be determined using model GW-2

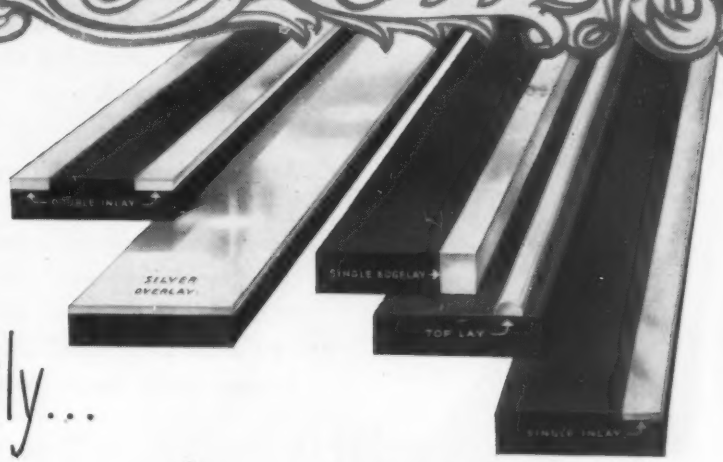


gradientometer that can also be switched for use as a magetometer. The device has been designed for investigating magnetic fields in aircraft frames.

New-Record Pickup

ASTATIC CORP., Conneaut, Ohio. Type FL-33 pickup and LP-33 crystal replacement cartridge have been designed particularly for use with new long-playing records. The

They all belong to the Same Cost-Cutting Family...



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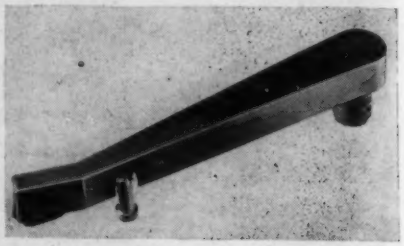
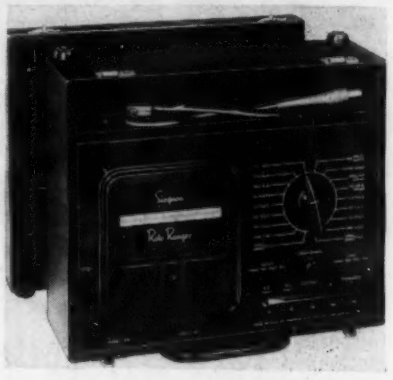
CANADIAN PLANT: The Cleveland Container Canada, Ltd., Prescott, Ontario



cartridge can be quickly interchanged with another that is suitable for the more conventional 78-rpm discs. An accessory filter type FL is also available.

Test Instrument

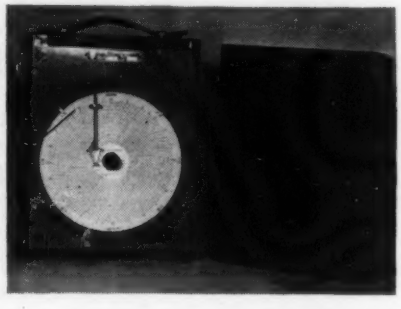
SIMPSON ELECTRIC Co., 5200 West Kinzie St., Chicago 44, Ill. Model 221 Roto-Ranger is a high-sensitivity a-c and d-c volt-ohm-milliammeter equipped with rotating dials.



Its many applications include measurements of afc diode balancing circuits, grid currents of oscillator tubes and power tubes, avc diode currents and high-mu plate voltage. Direct-current sensitivity is 20,000 ohms per volt.

Microcurrent Measurement

WALLACE & TIERNAN PRODUCTS, INC., Belleville 9, N. J. announce a portable d-c recorder for measuring microcurrents and voltages where exact range may be selected



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- and many others.

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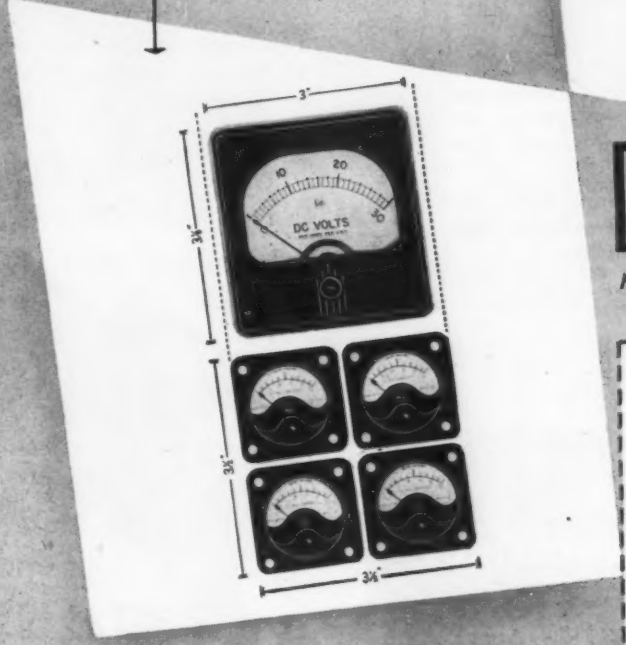
The DeJUR 1½-inch Model 112 Meter, measuring only 1¾ inches square and 25/32-inch deep is capable of doing a man-sized job where space is at a premium. This meter is built with fine watch precision. Available in standard ranges.



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INSTALLED IN
EAGLE SIGNAL'S MICROFLEX TIMER

Haydon engineers, in conjunction with the Eagle Signal Corporation, specified and produced to order the timing motor used in the Eagle's Microflex timer. The Microflex provides an exact adjustable delay between the closing of a control circuit and the subsequent opening or closing of a load circuit . . . a timer for industrial use where accuracy and dependability are paramount. The Microflex is but one example of Haydon's timing flexibility . . . based on teaming timing needs with such standard features of all Haydon motors as:

- **Adaptability for individual requirements . . . 60 standard speeds and other variations.**
- **Accuracy for all timing purposes**
- **Ruggedness for maximum service**

Thousands of industrial applications have proved the advantages of Haydon timing motors . . . designed to fit your particular timing needs . . . showing that it takes teamwork to make timing accuracy profitable.

If it's time for timing, it's time for Haydon. Engineering Data Catalog and expert field service available on request. For immediate reference, see Haydon Catalog, Sweet's File for Product Designers.

Write 2410 Elm Street, Torrington, Connecticut

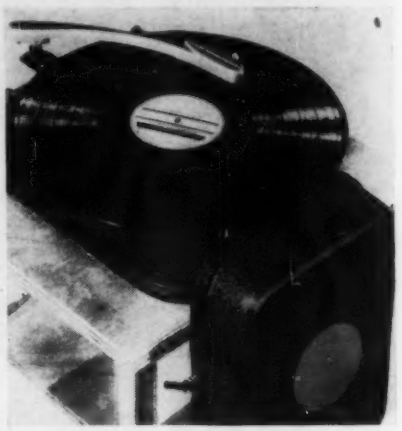
HAYDON

MANUFACTURING COMPANY, INC.
TORRINGTON CONNECTICUT
HARNESS TIME TO YOUR PRODUCTS
SUBSIDIARY OF GENERAL TIME INSTRUMENTS CORPORATION

by the user. The unit is of the moving magnet, interchangeable coil type and is designed for continuous duty. Minimum full scale range is 0 to 0.1 milliampere and maximum is 0 to 12 amperes. Sensitivity is 1 part in 1,000.

Transcription Player

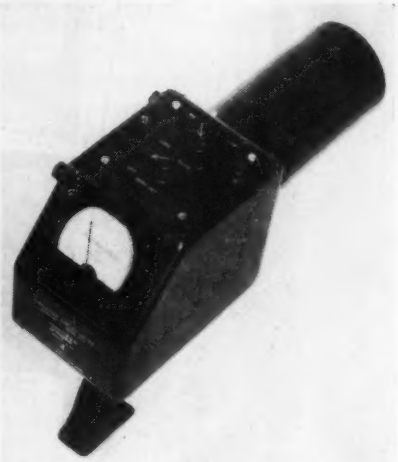
CALIFONE CORP., 1041 N. Sycamore Ave., Hollywood 38, Calif. introduce a new portable transcription player. It reproduces with both 16-in. transcriptions at 33⅓ rpm and regular phonograph records at 78 rpm. It features a wow-free



9-in. turntable, a pickup with replaceable permanent needle, a wide range amplifier and a heavy duty 6-in. speaker.

Small Radiation Meter

TRACERLAB, INC., 55 Oliver St., Boston 10, Mass. The Model SU-1A small portable radiation survey meter facilitates measurement of radiation in places difficult of ac-



KAY ELECTRIC COMPANY

KAY INSTRUMENTS
COVER ALL BANDS

Including the proposed HF-TV Bands (475-890 MC)

The MEGA-MATCH (Standard)

Simultaneous visual display of reflected energy from antennas and terminations when used with standard oscilloscopes. Band width of display 30 mc anywhere between 10 and 250 mc. Completely electronic. Includes no slotted lines, moving parts, bridges or other frequency sensitive devices. Oscilloscope display indicates amount of reflected energy vs frequency. Precision frequency meter indicates frequency anywhere along the oscilloscope display. Reflection coefficients as low as 0.01 can be observed. Internal delay cable allows display of energy from terminations of nominal 53.5 ohm impedance. External delay cable may be used to display reflected energy from terminations of any practical impedance. Reflection coefficients, standing wave ratios, absolute value of terminating impedance can be calculated from display—By use of auxiliary variable frequency signal source, the phase angle of the reflection coefficient and resistive and reactive components of terminating impedance may be calculated.

Price $695 f.o.b. factory

THE MEGA-MATCH (Modified)

The Mega-Match (Modified) meets all of the specifications and includes all the features of the standard model between 10 to 500 mc. With a slight increase in minimum observable reflection coefficient, this model can be used up to 1000 mc. Hence a visual display of reflected energy over band width up to 30 mc can be obtained from 10 to 1000 mc. This performance provides an instrument suitable for use in testing antennas, terminations, and r.f. input circuits in the proposed high frequency television bands and for other high frequency work. A convenient panel connector makes the Mega-Sweep which forms part of both the standard and modified models of the Mega-Match available as a sweeping oscillator.

Price $895 f.o.b. factory

Note: Standard models now in customers' hands modified at factory at price of $200 f.o.b. factory.

MEGA-SWEEP pulse modulated by the MEGA-PULSER

THE MEGA-SWEEP

The Mega-Sweep, a wide range sweeping oscillator has been widely used as a source of frequency modulated test signal. Its features include a wide sweep (up to 30 mc), low amplitude modulation while sweeping (less than 0.1 db. per megacycle), negligible output signal at frequencies other than swept band, low output impedance (50 ohms) and numerous others. It has been advertised as covering the frequency range of 50 kc to 500 mc since this range covered most requirements. By simple internal adjustment which can be made either by the customer or at our factory, its range can be extended to 1000 mc. The Mega-Sweep is therefore applicable to the proposed high frequency television bands and other high frequency work. By simple connections and adjustments the Mega-Sweep can serve as a carrier source when pulse modulated by the Mega-Pulser, providing ultra narrow pulsed r.f. at any frequency to 1000 mc.

Price $395 f.o.b. factory

THE MEGA-PULSER

Provides very narrow pulses (0.025, 0.05, 0.1 and 0.25 microseconds wide), amplitude 100 volts positive or negative across 50 ohms, repetition rate from internal trigger 100, 1000, 2000 pps. Output pulse delayed 0.25 microseconds from trigger pulser available (positive or negative) for starting sweep of auxiliary oscilloscope. Can be externally triggered by either positive or negative pulses. Output pulses .05 microseconds and greater flat-top, rise and fall time all output pulses 0.01 microseconds. Provides a spectrum which more than covers present or proposed television video amplifiers. The Mega-Pulser may be used to pulse modulate the Mega-Sweep with sweep width adjusted to zero. This combination provides a pulse modulated carrier up to 1000 mc for studying transient response of broad band r.f. circuits.

Price $195 f.o.b. factory

WRITE FOR FULL SPECIFICATIONS

KAY ELECTRIC CO., 25 MAPLE AVE., PINE BROOK, N. J.

Telephone: CAldwell 6-3710

INSTRUMENTS

HAYDON 1600 SERIES MOTOR
INSTALLED IN
EAGLE SIGNAL'S MICROFLEX TIMER

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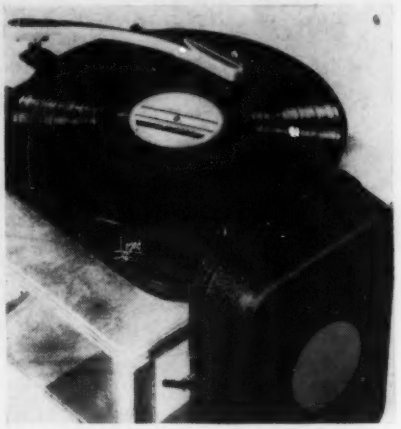

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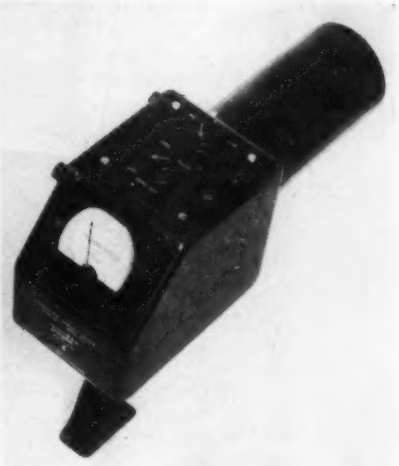

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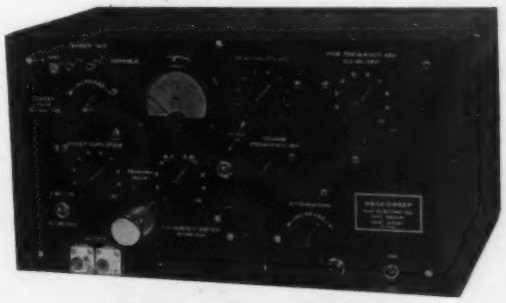

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INSTRUMENTS

A Ballantine

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For every requirement

ALL MODELS HAVE THE
SIMPLIFIED LOGARITHMIC SCALE

STANDARD
Model 300

Ideal for the *Accurate* measurement of AC voltages in the Audio, Supersonic, Carrier Current and Television ranges.

Use of Logarithmic voltage scale assures uniform accuracy of reading over whole scale while permitting range switching in decade steps.

Each Voltmeter equipped with an output jack so that the instruments can be used as a high-gain stable amplifier.

Model 304
R-F
VOLTMETER

SPECIFICATIONS

MODEL 300

RANGE—.001 to 100 volts.
FREQUENCY—10 to 150,000 cycles.
ACCURACY—2% at any point on scale.
AC OPERATION—110-120 volts.

MODEL 304

RANGE—.001 to 100 volts.
FREQUENCY—30 c.p.s. to 5.5 megacycles
ACCURACY—0.5 DB.
AC OPERATION—110-120 volts.

MODEL 302

RANGE—.001 to 100 volts
FREQUENCY—5 to 150,000 cycles.
ACCURACY—2% at any point on scale.
DC OPERATION—self-contained batteries.

Send for Bulletin for further description

Model 302
BATTERY
OPERATED

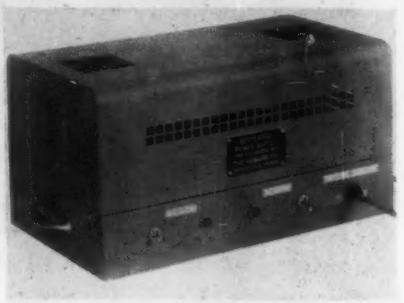
BALLANTINE LABORATORIES, INC.

BOONTON, NEW JERSEY, U. S. A.

cess. The unit has three full-scale ranges of approximately 25, 250 and 2,500 milliroentgens per hour. It is powered by ten small batteries mounted in a replaceable lucite enclosure within the main instrument case.

Regulated Power Supply

THE HOWARD CO., 934 Argyle Road, Drexel Hill, Pa. The new 300-volt, 200-ma power supply is regulated



within 1 volt from zero to full load with line voltage variation from 105 to 125 volts. Ripple is less than 10 millivolts at full load with 115 volts input.

Microgroove Changer

WEBSTER-CHICAGO CORP., 5622 Bloomingdale Ave., Chicago 39, Ill. Model 133 has been designed to play new long-playing records at

33.3 rpm. The unit will handle up to ten 12-in. or twelve 10-in. records for a total playing time of four hours. Retail price is $38.75.

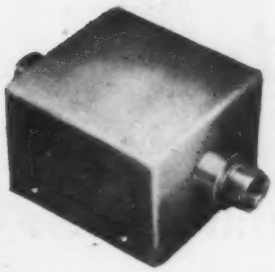
High-Fidelity Recording

PRECISION AUDIO PRODUCTS, INC., 1133 Broadway, New York 10, N. Y. The Wiremaster, a new wire recorder, has 13 tubes with push-pull 6V6 output and records and reproduces a frequency response of 40 to 10,000 cycles. Its 8-in. extended

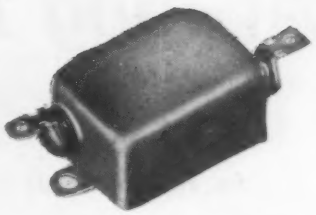
AIRCRAFT MANUFACTURERS RELY ON...

FILTRONS

...TO SOLVE THEIR RADIO NOISE PROBLEMS



Shielded Spherical-Seat Terminal Filtron—designed for continuous high attenuation from 150 kc to well above 200 mc



2.5 amp Filtron for 50 V.D.C. operation size 1¾" x 1¼" x ⅞"

100 amp & 200 amp 50 Volt Aircraft Filtrons, size 3½" x 3½" x 2½"

FILTRONS OFFER:

- Low Cost • High Attenuation
- Dependability • Light Weight
- Small Size • No Maintenance
- Hermetically Sealed

Boeing B50 filtered by Filtron for radio interference-free operation.

FILTRONS *STOP* CONDUCTED AND RADIATED INTERFERENCE AT THE SOURCE

THOUSANDS OF FILTRONS—radio interference filters—are standard equipment on the majority of current Aircraft production. Thousands of others are in use in vital equipment where radio interference must be suppressed.

Filtron's experienced Engineers, recognized authorities in the noise-suppression field, are available—immediately—to measure the RF interference caused by your product, and to specify a standard Filtron, or design the proper filter to meet Army, Navy, Air Force or FCC interference specifications.

Filtron will design the RIGHT filter for your circuit conditions, with exactly the right attenuation, ampere rating, voltage drop, temperature rise, mechanical arrangement, and space and weight limitations. Filtrons of any current or voltage rating will be designed to meet your application.

Filtron's production capacity and skill will meet your delivery requirements.

All measurements are made in our new modern specially-designed shielded Radio Noise Suppression Laboratory.

"Filtron," the largest exclusive manufacturer of Radio Noise Filters, offers you the PROMPT services of their Engineers and facilities to make your product "Noise Free."

RADIO NOISE FILTERS FOR:

- Electric Motors
- Electric Generators
- Electronic Controls
- Electronic Equipment
- Fluorescent Lights
- Oil Burners
- Signal Systems
- Business Machines
- Electronic Heating Equipment
- Electric Appliances
- Electronic Signs

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Write for catalog on your letterhead—it contains complete electrical and mechanical characteristics of standard Filtrons.

LARGEST EXCLUSIVE MANUFACTURER OF RADIO NOISE FILTERS

At long last—

The G.M. counter tube reaches maturity in the new all metal *THYRODE 1B85

The new THYRODE is a precision counter tube, designed to utilize quantity production methods. The .005 inch aluminum wall, rib re-enforced, adds strength to its inherent stability and accuracy.

Priced at $7.50

CHARACTERISTICS

Overall length	4-1/8 inches
Active length	2-3/4 inches
Shell diameter	3/4 inches
Absorption	30 mgm/cm²
Operating voltage (center of plateau)	900 volts
Plateau length	200 volts
Plateau slope	3% / 100 volts
Temperature range	5° C. to 70° C.
Life	10^8 counts

*THYRODE
A Victoreen trademark for radiation counter tubes

Victoreen radiation measuring instruments for laboratory and field determinations together with such components as the VX series subminiature electrometer tubes, vacuum sealed hi-meg resistors and G-M counter tubes have made notable contributions to the present refinement of radiation instrumentation.

Victoreen 5806 Hough Avenue Cleveland 3, Ohio

range speaker is in a separate cabinet to avoid vibration and acoustical feedback. By panel controls the user can record on wire directly from the self-contained radio or phonograph. Spools are available in 15, 30 and 60-minute lengths.

Literature

House Organ. Micro Switch, Freeport, Ill. Micro Tips, vol 1, no. 2 contains a number of suggestions for use of snap action switches including one for pushing the dog out after dinner.

Portable Flaw Tester. Sperry Products Co., Danbury, Conn. The new portable SR05 Supersonic Reflectoscope is pictured in reprint 3013 and further described in bulletin 3001.

Wire Dereelers. Rea Magnet Wire Co., Inc., Fort Wayne, Indiana, has put out a two-color, 4-page brochure on a line of magnet wire dereelers that load quickly and give visibility in the running position.

Special Tools. Palnut Co., 61 Cordier St., Irvington 11, N. J. Special adaptors for many ordinary hand tools to adapt them to speedier assembly with Palnuts only are described in a 4-page brochure.

General Price List. Andrew Corp., 363 E. 75th St., Chicago 19, Ill. Bulletin 10A is a comprehensive tabulation of all transmission

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McGraw-Hill Industrial Mailing Lists are a direct route to today's purchase-controlling executives and technicians in practically every major industry.

These names are of particular value now when most manufacturers are experiencing constantly increasing difficulty in maintaining their own lists.

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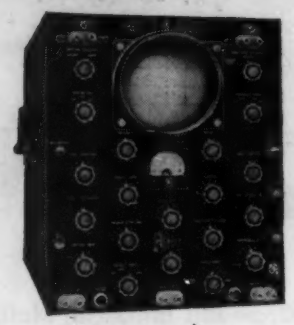
Laboratory and Research Instruments

ENGINEERED FOR ENGINEERS

OSCILLOSYNCHROSCOPE

Model OL-15B



Designed for maximum usefulness in laboratories doing a variety of research work, this instrument is suited to radar, television, communication, facsimile, and applications involving extremely short pulses or transients. It provides a variety of time bases, triggers, phasing and delay circuits, and extended-range amplifiers in combination with all standard oscilloscope functions.

THESE FEATURES ARE IMPORTANT TO YOU

- **Extended-range amplifiers: vertical, flat within 3 db 5 cycles to 6 megacycles; horizontal, flat within 1 db 5 cycles to 1 megacycle.**
- **High sensitivity: vertical, 0.05 RMS volts per inch; horizontal 0.1 RMS volts per inch.**
- **Single-sweep triggered time base permits observation of transients or irregularly recurring phenomena.**
- **Variable delay circuit usable with external or internal trigger or separate from 'scope.**
- **Sawtooth sweep range covers 5 cycles to 500 kilocycles per second.**
- **4,000 volt acceleration gives superior intensity and definition.**

For complete data, request Bulletin 4810-MO

SWEEP CALIBRATOR

Model GL-22

This versatile source of timing markers provides these requisites for accurate time and frequency measurements with an oscilloscope:

- **Positive and negative markers at 0.1, 0.5, 1.0, 10, and 100 microseconds.**
- **Marker amplitude variable to 50 volts.**
- **Gate having variable width and amplitude for blanking or timing.**
- **Trigger generator with positive and negative outputs.**

Further details are given in Bulletin 4810-MC.

SQUARE-WAVE MODULATOR AND POWER SUPPLY

Model TVN-7

Here is the heart of a super high frequency signal generator with square wave, FM, or pulse modulation. Provides for grid pulse modulation to 60 volts, reflector pulse modulation to 100 volts, square wave modulation from 600 to 2,500 cycles. Voltage-regulated power supply continuously variable 280-480 or 180—300 volts dc. For additional data and application notes, see Bulletin 4810-MM.

STANDING WAVE RATIO METER AND HIGH GAIN AUDIO AMPLIFIER

Model TAA-16

- **Standing wave voltage ratios are read directly on the panel meter of this sensitive, accurate measuring instrument.**
- **Frequency range 500 to 5,000 cycles per second.**
- **Two input channels with separate gain control for each.**
- **"Wide-band" sensitivity 15 microvolts full scale.**
- **"Selective" sensitivity 10 microvolts full scale.**
- **Bolometer/crystal switch adjusts input circuit to signal source.**

Write for Bulletin 4810-MA containing full details of this useful instrument.

***In Canada, address* Measurement Engineering Ltd., Arnprior, Ontario.**

line, antenna, and related equipment, with type numbers, descriptions and prices for over 600 items. A cross index is enclosed with the bulletin.

Fiber. Spaulding Fibre Co., Inc., 310 Wheeler St., Tonawanda, N. Y. Various types and grades of fiber rod are summarized and listed in a recently issued brochure.

Fasteners. Shakeproof Inc., 2501 North Keeler Ave., Chicago 39, Ill., has issued a booklet entitled "Fastening Suggestions" that describes a number of special fastener problems and their solution.

Shielded-Section Capacitor. Cornell Dubilier, South Plainfield, N. J. A shielded multiple section capacitor type MC-9A63 has four 0.02-microfarad sections with voltage ratings for 500 v d-c. Details are given in sheet NB-107.

Rectifier. National Electronics, Inc., Geneva, Ill., has recently released full technical information on the new single ended 2-ampere industrial rectifier tube type NL-649.

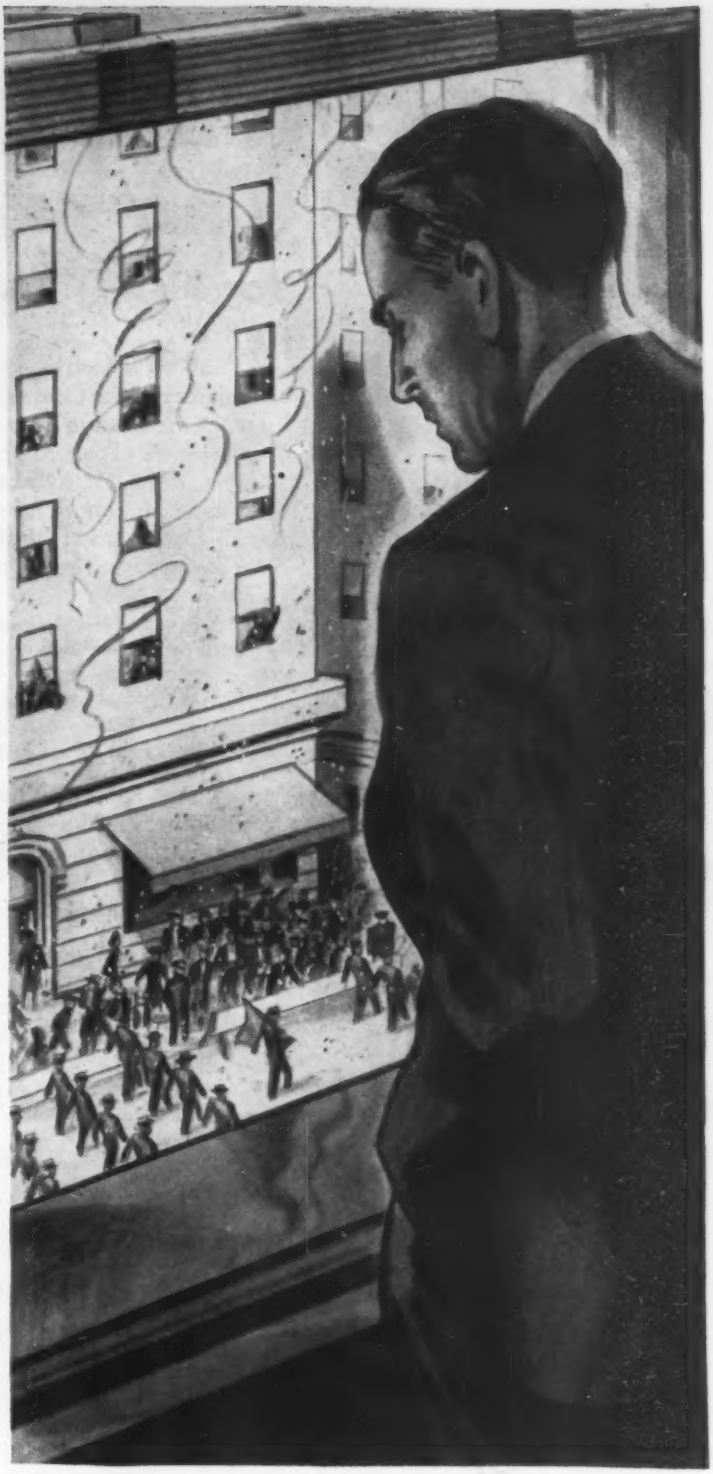
Brushes. Stackpole Carbon Co., St. Marys, Pa. A 44-page "Fractional Horsepower Equipment User's Guide" just issued contains helpful information on selecting and applying brushes for longer life and better performance.

Battery Terminal. James A. Stanley Co., 277 Broadway, New York 7, N. Y. A brochure can be had describing the new B-319 battery terminal that employs a spring-tension connection to a storage battery terminal post. The new terminal is particularly useful in mobile radio installations.

A-C Motor Control. Louis Allis Co., Milwaukee 7, Wis. Characteristics of the Ajusto-Spede are presented in four pages. The device is characterized as an a-c motor having infinitely adjustable speed.

Photoelectric Counter. Photoswitch, Inc., 77 Broadway, Cambridge 42, Mass. Bulletin PA482

MEMO TO PRESIDENTS WHO WATCHED THE BAND GO BY!



HERE'S ONE parade that isn't "all over but the shouting" after the band has passed. It's the Payroll Savings Plan for the regular purchase of U.S. Security Bonds by employees.

Though the formal spring campaign to sell Bonds is over, any company can still move forward with the parade. Right now thousands of companies are putting *additional push* behind their Payroll Savings Plans. Managements of many companies that have not yet participated are *now installing* the Plan.

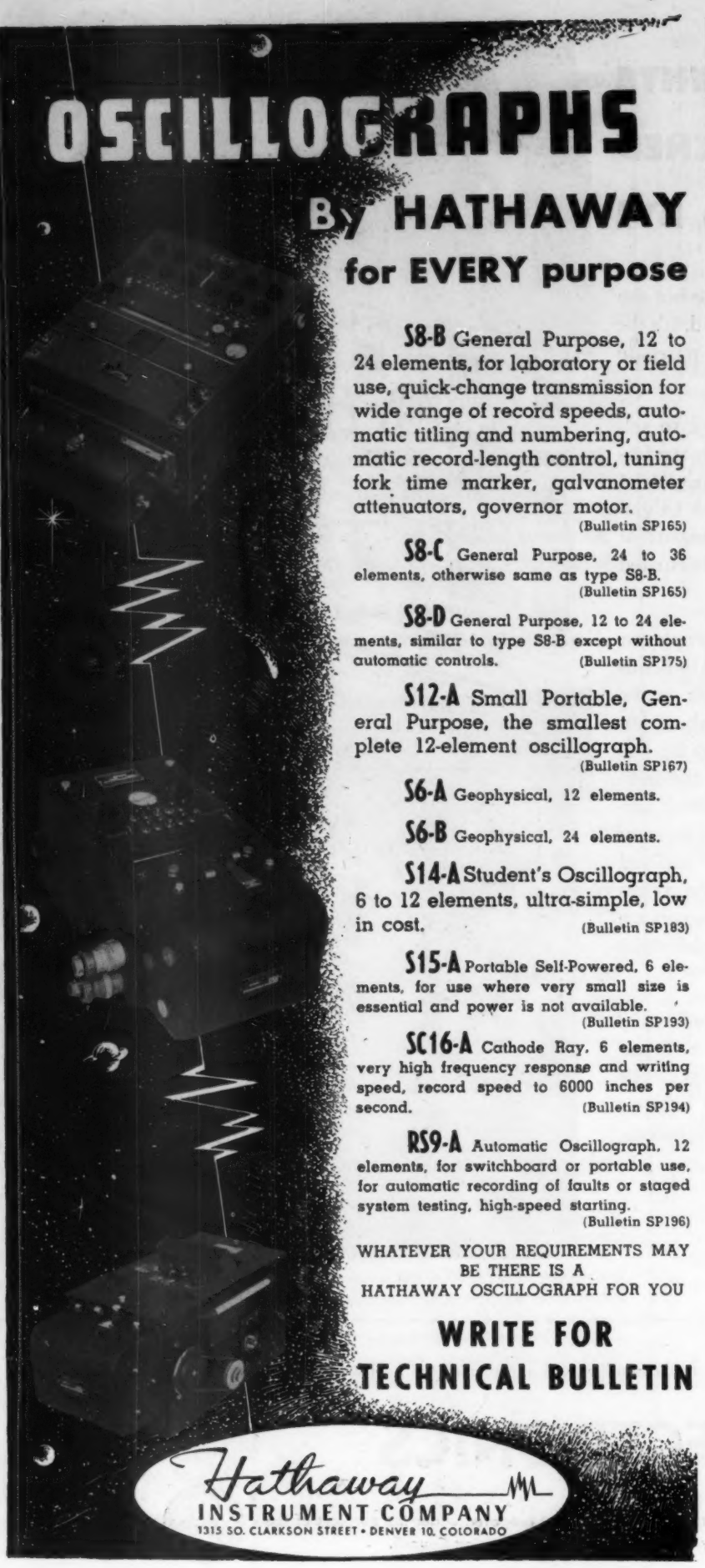
It's a "look-ahead" plan, that benefits employee, company, and nation. Every $3 invested in Bonds pay $4 at maturity. Personnel records in the plants with active P.S.P. programs show improved employee attitudes—evidenced by less absenteeism and fewer accidents—as the individual's sense of security grows with Bond purchases. And every Security Bond dollar built up in the Treasury retires a dollar of the national debt that is potentially inflationary. It means less bidding-up of prices. Moreover, Bond buyers are better citizens because they have a tangible stake in the nation's future.

It's just as easy to take action now as when the campaign was at its height. Just call your Treasury Department's State Director, Savings Bonds Division, and ask for the material that helps to get a Payroll Plan started or to keep it rolling.

The Treasury Department acknowledges with appreciation the publication of this message by

ELECTRONICS

This is an official U. S. Treasury advertisement prepared under the auspices of the Treasury Department and the Advertising Council.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S8-B General Purpose, 12 to 24 elements, for laboratory or field use, quick-change transmission for wide range of record speeds, automatic titling and numbering, automatic record-length control, tuning fork time marker, galvanometer attenuators, governor motor. (Bulletin SP165)
S8-C General Purpose, 24 to 36 elements, otherwise same as type S8-B. (Bulletin SP165)
S8-D General Purpose, 12 to 24 elements, similar to type S8-B except without automatic controls. (Bulletin SP175)
S12-A Small Portable, General Purpose, the smallest complete 12-element oscillograph. (Bulletin SP167)
S6-A Geophysical, 12 elements.
S6-B Geophysical, 24 elements.
S14-A Student's Oscillograph, 6 to 12 elements, ultra-simple, low in cost. (Bulletin SP183)
S15-A Portable Self-Powered, 6 elements, for use where very small size is essential and power is not available. (Bulletin SP193)
SC16-A Cathode Ray, 6 elements, very high frequency response and writing speed, record speed to 6000 inches per second. (Bulletin SP194)
RS9-A Automatic Oscillograph, 12 elements, for switchboard or portable use, for automatic recording of faults or staged system testing, high-speed starting. (Bulletin SP196)
WHATEVER YOUR REQUIREMENTS MAY BE THERE IS A HATHAWAY OSCILLOGRAPH FOR YOU
WRITE FOR TECHNICAL BULLETIN
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shows the various uses for type 20 AP5 photoelectric counter designed particularly for case and bottle counting, textile and leather piece goods, as well as freshly painted and hot objects.

Electrosensitive Papers. A[merican] Paper and Engineering Co., [2]0 Riverside Ave., Brockton 27, M[ass.] Papers for all kinds of recordi[ng] devices that employ electroly[tic] papers are described in a minim[eo]graphed brochure that gives ch[ar]acteristics and prices.

Hardware and Parts. General Cement Mfg. Co., Rockford, Ill. A new 64-page catalog recently issued lists radio and electronic products, chemicals, hardware, kits, insulation, and other items of interest in the electronics field.

Meters. Millivac Instruments, PO Box 3027, New Haven, Conn. Type MV717A vacuum-tube millivoltmeter and type MV73A multipurpose vacuum tube meter are both pictured in brochures recently made available from the company.

Marking Machines. Adolph Gottscho, Inc., 1 Hudson St., New York 13, N. Y. An 8-page catalog describes 18 different marking and code-dating machines that are useful in packaging all types of electronic equipment.

Molded Cores. Lenkurt Electric Co., 1113 County Road, San Carlos, Calif. "Trancors by Lenkurt" is the title of a new 24-page folder describing a complete line of molded magnetic cores, core assemblies, coil assemblies, and filters.

Speaker Folder. Altec Lansing Corp., 250 West 57th St., New York 19, N. Y. A two color folder announces a new line of general purpose loudspeakers. Frequency response curves and methods of obtaining the curves are presented. Available cabinets are also illustrated.

Contactors. Ward Leonard Co., 31 South St., Mount Vernon, N. Y. For the bigger transmitters and heavy industrial control equipment engineers will want to see

copies of bulletins 4452 and 4453 describing heavy-duty solenoid contactors.

High-Frequency Resistors. International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa. Complete specifications and characteristics for type MP high-frequency resistors are given in a 4-page technical data bulletin F-1.

Motor Controls. Square D Co., 4041 N. Richards St., Milwaukee 1, Wis. New products and modification listings for holders of the Electric Motor Control catalog were issued as of July 28, 1948.

Crystals. Reeves-Hoffman Corp., 321 Cherry St., Carlisle, Pa. A catalog covers the complete line of quartz crystal units for calibration, mobile, aircraft, and commercial crystal applications. Bulletin RHC features a small universal holder for frequency coverage from 50 kc to 100 mc.

A-M Transmitters. Radio Corp. of America, Camden, N. J. A 24-page descriptive brochure provides comprehensive information on 5-kw and 10-kw a-m broadcast transmitters. It is profusely illustrated with schematic diagrams, specifications, layouts, and photographs. Write Department 516.

Capacitor, Tetrode, and Socket. Eitel-McCullough, Inc., San Bruno, Calif. Variable vacuum capacitors that can be mounted singly or in gangs, the type 4-400A r-f amplifier power tetrode, and the special air-system socket are all pictured in brochures available from the company.

Metal Problems. International Nickel Co., Inc., 67 Wall St., New York 5, N. Y. A new booklet entitled "66 Practical Ideas for Metal Problems in Electrical Products" should be interesting reading for the designer of electronic products with problems in choice of proper metal for fabrication.

Assorted Instruments. Kalbfell Laboratories, Inc., 1076 Morena Blvd., San Diego 10, Calif. A heterodyne detector, bridged-T filter, decade amplifier, and the

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For Inverting D. C. to A. C. . . .

Specially Designed for operating A. C. Radios, Television Sets, Amplifiers, Address Systems, and Radio Test Equipment from D. C. Voltages in Vehicles, Ships, Trains, Planes and in D.C. Districts.

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Type "M" Blocks are designed with ample clearance and creepage distances for use in circuits carrying up to 300 volts, 15 amps.

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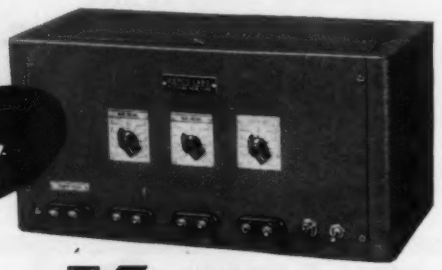
Separate voltage supplies eliminated



Four commonly used voltages from a single compact unit! Separate voltage supplies, ordinarily derived from three or four cumbersome power units, now concentrated in one!. That is what the Kepco Multiple Power Supply brings to busy engineers in the industrial laboratory, for greater convenience and speed in experiments and research work.

Any voltage you need is instantly available through the Kepco Multiple Power Supply—for heater, plate and grids—for studying the characteristics of vacuum and gas filled tubes. Contains:

Two continuously variable B supplies from 0 to 300 volts or currents up to 120 ma.
One continuously variable C supply from minus 50 to plus 50 volts at 5 ma.
One heater supply delivering 6.3 volts at 5 amperes.

The two B supplies originate from a common power transformer; the C supply originates from a separate power transformer and rectifying circuit. B supplies cannot be burned out even if terminals are shorted. Control circuit eliminates the use of heavy duty power potential dividers.

Complete voltage control from front panel, including power switch and pilot light indicating "Off" and "On." All voltages brought out to binding posts along lower edge of front panel.

Strong construction; all component parts of highest quality. Dimensions: Length 16"; height 8"; depth 8 ¾". Weight 28 lbs.

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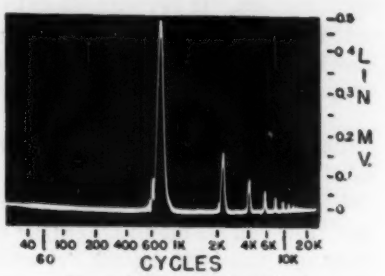
Reduce time, complexity and cost of making audio measurements with the unusual advantages offered by the Panoramic Sonic Analyzer. By resolving a complex audio wave into a spectrograph showing the frequency distribution and voltage amplitude of the components, Model AP-1 . . .

• Eliminates slow point-by-point frequency checks • Provides a quick overall view of the audio spectrum • Enables determination of changes in waveform content while parameters are varied • Furnishes simple presentations for production line testing.



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micro-miker are briefly listed on a specification sheet.

Components. Aircraft Radio Corp., Boonton, N. J. A series of bulletins made up in catalog form covering a wide variety of test equipment, microwave accessories and electronic component parts. Photographs and mechanical drawings are included.

Wire Catalog. Alpha Wire Corp., New York 13, N. Y. A complete line of wire and wire products for the radio, automotive and electrical industries is covered in the twelve-page catalog no. 48. Specifications for each type are given.

Coil Winding. Universal Winding Co., P.O. Box 1605, Providence 1, R. I. Information covering improvements in coil winding equipment and new ideas in the winding operation may be found in a series of single sheet publications.

Capacitor Information. Herlec Corporation, 422 North Fifth St., Milwaukee 3, Wisconsin, recently issued two new catalog sheets. One deals with types, physical dimensions and standard values of bypass and audio coupling capacitors together with diagrams of "Bulplates," incorporating several capacitors. The other gives a general description, specifications, and instructions for ordering metal cup capacitors.

Antennas. Tricraft Products Co., 1535 N. Ashland Ave., Chicago 22, Ill., presents in a 16-page booklet the electrical performance data on the models 300 and 400 all-wave television and f-m antennas. Two descriptive catalog leaflets are also included.

Machining Plastics. Monsanto Chemical Co., Springfield, Mass. Bulletin 52 tells how to do it if the cost of a polystyrene plastic article is below that warranting the use of an expensive mold.

Tube Applications. Radio Corp. of America, Harrison, N. J. Several new tube application notes numbered AN-134 through AN-137 have recently been issued dealing with adjustment of filament voltage

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FROM the primary elements that enter into the assembly of a General Electric speaker, down to the completed unit, tests are made continuously to maintain quality standards.

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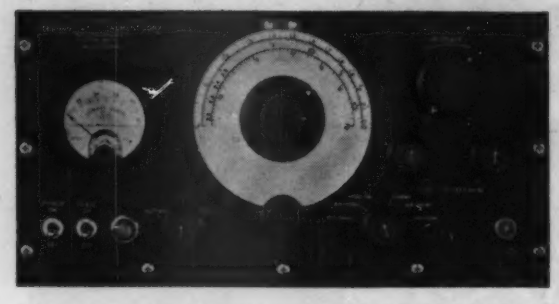

for general laboratory use and as a signal source for R-F bridges

Write today for Bulletin 408 containing complete information and specifications on the Type 410-A R-F Oscillator

NOTE THESE FEATURES

- 100 kc to 10 Mc
- High output—approximately 30 volts
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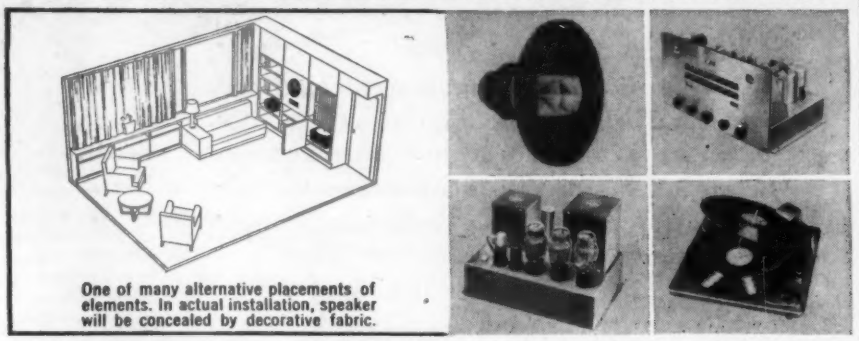

One of many alternative placements of elements. In actual installation, speaker will be concealed by decorative fabric.

The Altec Lansing Custom-in-Built Music System consists of the famous Altec Lansing Duplex speaker, a special Altec Lansing amplifier, a newly designed TRF Altec Lansing AM-FM tuner, and the Webster 70 record changer with GE variable reluctance pick-up. Integrated with the structure of your room, this system transcends completely the inherent acoustical and electronic limitations of conventional radio-phonographs, eliminates radio "furniture," and reproduces the full range of sound (35 to 16,000 cycles). It achieves the highest faithfulness to living sound now known to science. Built-in Altec Lansing Daylight Television can also be included. Complete installation instructions come with each system.

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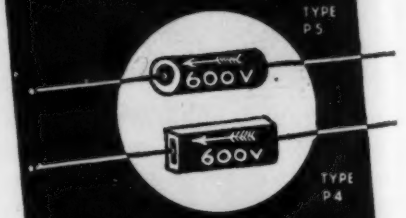

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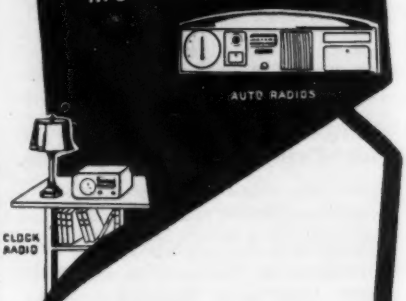

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are the largest selling miniature paper capacitors in the world.

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308 DYCKMAN ST., NEW YORK N. Y.

of the 1B3 by observation of filament temperature, reduction in peak inverse voltage rating, overload protection for horizontal deflection circuits, and single-section filament operation of 3S4 and 3V4.

Marine Radiophones. Rex Bassett, Inc., Fort Lauderdale, Fla. A folder lists the various two-way marine radiotelephones for tug boats, fishing vessels, tankers and yachts.

Tubes. Radio Corp. of America, Harrison, N. J. Specification sheets on the type 812-A power triode, type 672-A thyratron, and the type 4X500A power tetrode are now in printed form.

High-Power Solenoid. B/W Controller Corp., Birmingham, Mich. Bulletin SOL-2 devotes four pages to an illustrated description of the Hi Power small space, a-c solenoid. Specifications, charts and dimensional drawings are included.

Cast Parts. Austenal Laboratories, Inc., 224 E. 39th St., New York 16, N. Y. A 16-page booklet entitled "New Horizons with Microcastings" contains a number of interesting examples of parts produced by the Microcast process for use in the electronics field.

Synthetic Elastics. E. I. duPont de Nemours and Co., Inc., Fairfield, Conn. Properties and uses of Fairprene, a synthetic elastic composition are described in a 12-page manual. Each of the three groups of Fairprene products is illustrated.

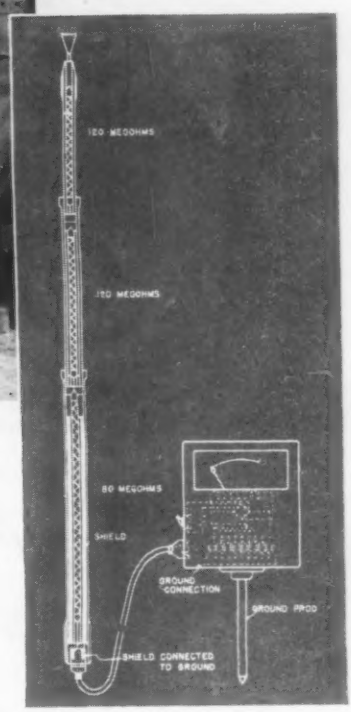
Air-spaced Cables. Transradio Ltd., 138A Cromwell Road, London SW7, England. Publication 27 lists new types of Co-Ax air-spaced articulated r-f cables. They can be used for flexible high-power transmission lines, very low-capacitance cables, and photocell leads.

Transformers. Electro Engineering Works, 6021 College Ave., Oakland 11, Calif. Using modern techniques, this company makes all types of radio, industrial, audio, and other transformers as

S·S·White MOLDED RESISTORS
The "All-Weather" Resistors

INSURE ACCURACY AND RELIABILITY
IN *Hipot* INSULATION TESTERS

Photo and Illustration courtesy of Canadian Line Materials, Ltd. Toronto, Canada



(Above) Schematic wiring diagram of the "Hipot" test stick. Each telescoping stick section contains a number of S.S.White Resistors hooked up in series. This permits the resistances to be varied from 72 to 312 megohms.

The "Hipot" Test Stick is used to test Bushings and Insulators on high voltage transmission lines from 11 to 230 KV. It consists of telescoping bakelite stick sections each containing a series of S.S.White Resistors to step the voltages down to minute values for measurement.

The manufacturer, Canadian Line Materials, Ltd., Toronto, Canada says —"We have always found S.S.White Resistors of highest quality. They have characteristics which insure consistently accurate and dependable readings on the indicating instruments."

WRITE FOR BULLETIN 4505

It gives essential data about S.S.White Resistors including construction, characteristics, dimensions, etc. Copy with price list on request.

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FLEXIBLE SHAFTS • FLEXIBLE SHAFT TOOLS • AIRCRAFT ACCESSORIES
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Cyclohm 2500 Motors are designed with greater *precision* and *compactness* than any other motors of their type—and the result is *greater output . . . perfect rigidity . . . quieter performance. Synchronous* type for instruments, timing devices and facsimile operations . . . *Non-Synchronous* for general applications . . . *Speed Reducer* for work requiring slow speeds and high torques. Ball bearings or sleeve bearings.

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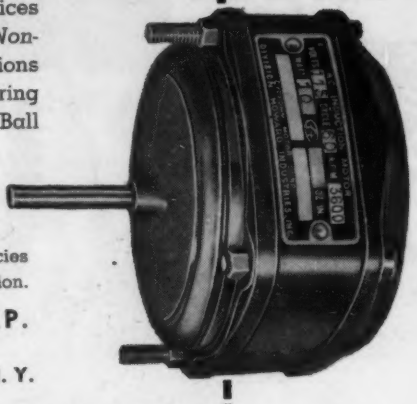

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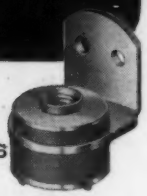
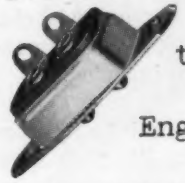


in quantities suitable to Volume Production...it may pay you to call upon



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well as magnets and saturable reactors, according to a catalog sheet just issued.

Industrial Glass. Kopp Glass, Inc., Swissvale, Pa. A new 24-page bulletin just printed in color describes glass products for industry, including some for the electronics field.

Vibration Control. Vibrashock Division of Robinson Aviation, Inc., Malcolm Ave., Teterboro, N. J., announces a new catalog, particularly for product design engineers, showing complete suspensions for the mounting of equipment in standard and special sizes. The many factors entering into vibration control are treated.

Insulation Testing. Associated Research, Inc., 231 S. Green St., Chicago 7, Ill. Bulletin 302 explains the applications and use of the model 404 Hypot, an instrument which independently tests breakdown, leakage, and shorting of insulation with the use of lights to discriminate between them. Range is from 0 to 4,000 volts.

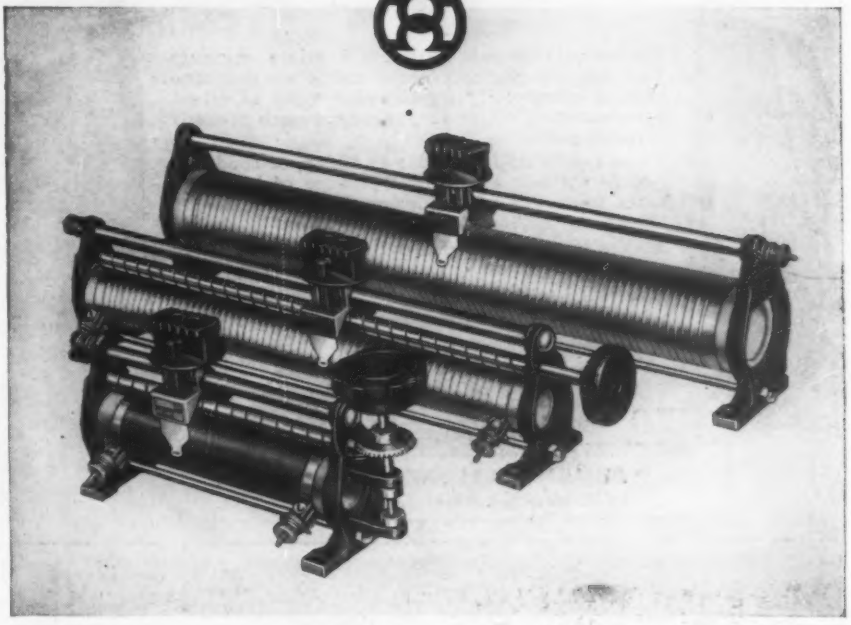
Plastics. General Electric Co., Chemical Dept., Pittsfield, Mass. Bulletin CDP-578 is a 15-page illustrated description of molded and laminated plastics. Also discussed are sealing caps and sleeves, mycalex, silicone rubber, and h-f insulation. Property tables are included for reference.

Permanent Magnets. General Electric Co., Chemical Dept., Pittsfield, Mass. CDM-12 is an eight-page illustrated bulletin describing cast and sintered Alnico, Cunife, Cunico, Vectolite, Silmanal and various permanent magnet holding assemblies. Special alloys are also discussed.

Interlock Switch. Micro Switch, Freeport, Ill. Data sheet no. 45 describes the 1AC1 and 1AC2 interlock door switches designed for use on h-f radio, radar, x-ray and television equipment cabinets, induction heating equipment, and electronic controls of all types.

Electromatic Tester. Tinius Olsen Testing Machine Co., 1022 Easton Rd., Willow Grove, Pa. Bulletin 37

HARDWICK, HINDLE
Tubular Rheostats



THESE FINE SLIDING contact rheostats are widely used in laboratories. They serve as rheostats or potentiometers;—portable, easily mounted, with fine gradations of adjustment.

These sturdy, improved tubular rheostats are used for accurate adjustment of voltage or current in meter-checking laboratories; —as field rheostats for generator and motor control;—as filament and plate control in radio and audio transmitting and amplifying apparatus;—for control of illumination and heat control in electric furnaces and ovens; as well as in general laboratory use.

Available in 3 sizes: 200, 400 and 750 watts with any one of 3 types of control.

Hardwick, Hindle resistors and rheostats offer many exclusive advantages. We ask you to give our engineers an opportunity to discuss your specific requirements.

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The Advance Hermetically Sealed Relay

Hermetically sealed ADVANCE relays maintain their original efficiency under conditions that soon ruin or dangerously impair other types of relays. Dust, moisture, oil, or fungus cannot reach precisely adjusted parts.

There can be no failure due to arcing, or condensation in the low atmospheric pressure of high altitudes. Important, too, is the fact that these relays are "Tamper-Proof"!

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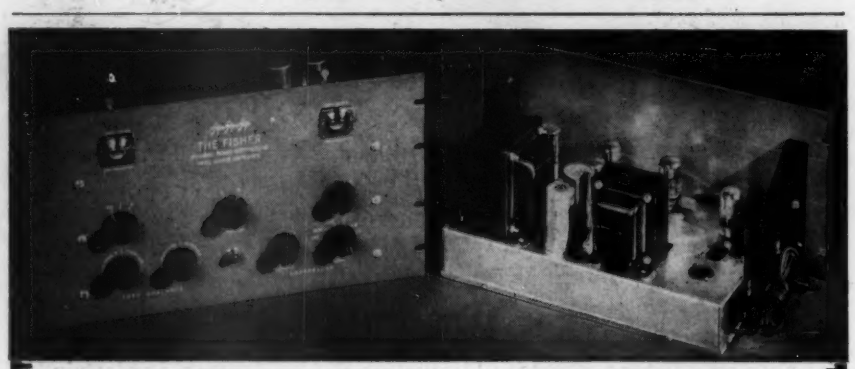

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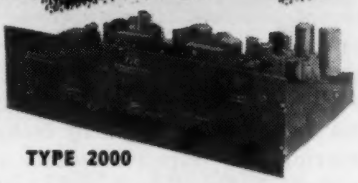


TYPE 2000

BAR & DOT GENERATOR

Efficient push-button unit for swift, precise adjustment of horizontal & vertical sweep linearity of television receivers. Used in conjunction with Standard Synchronizing Signal and Monoscope Generator or other pattern or picture signal generator. Requires only 5¼" of standard rack space. Five convenient push-buttons allow instantaneous selection of: • Standard blanking • Vertical bars only • Horizontal bars only • Vertical & horizontal bars • Complete dot pattern. Has phasing control for adjustment of vertical bar position. Power supply is self contained.

TYPE 1900

CRYSTAL CONTROLLED MULTI-FREQUENCY GENERATOR

A 10 frequency, 400 cps modulated crystal controlled oscillator, ideal for production line adjustment of stagger tuned I.F. amplifiers in television sets. Available with crystals ranging from 17 to 40 mc. provided to exact frequency and in sequence specified by customer. Each frequency is immediately selectable by means of a push button. Output adjustable. Power supply is self contained.

Write for bulletins 2000 & 1900

TEL Instrument Co. Inc.
50 PATERSON AVE.
East Rutherford, New Jersey
RUtherford 2-9720

is a four-page folder devoted to the Electromatic low-capacity universal testing machine. The unit gives wide spread ranges of 250 to 1, extension ranges of 200 to 1 and straining ranges of 400 to 1. Complete specifications are listed.

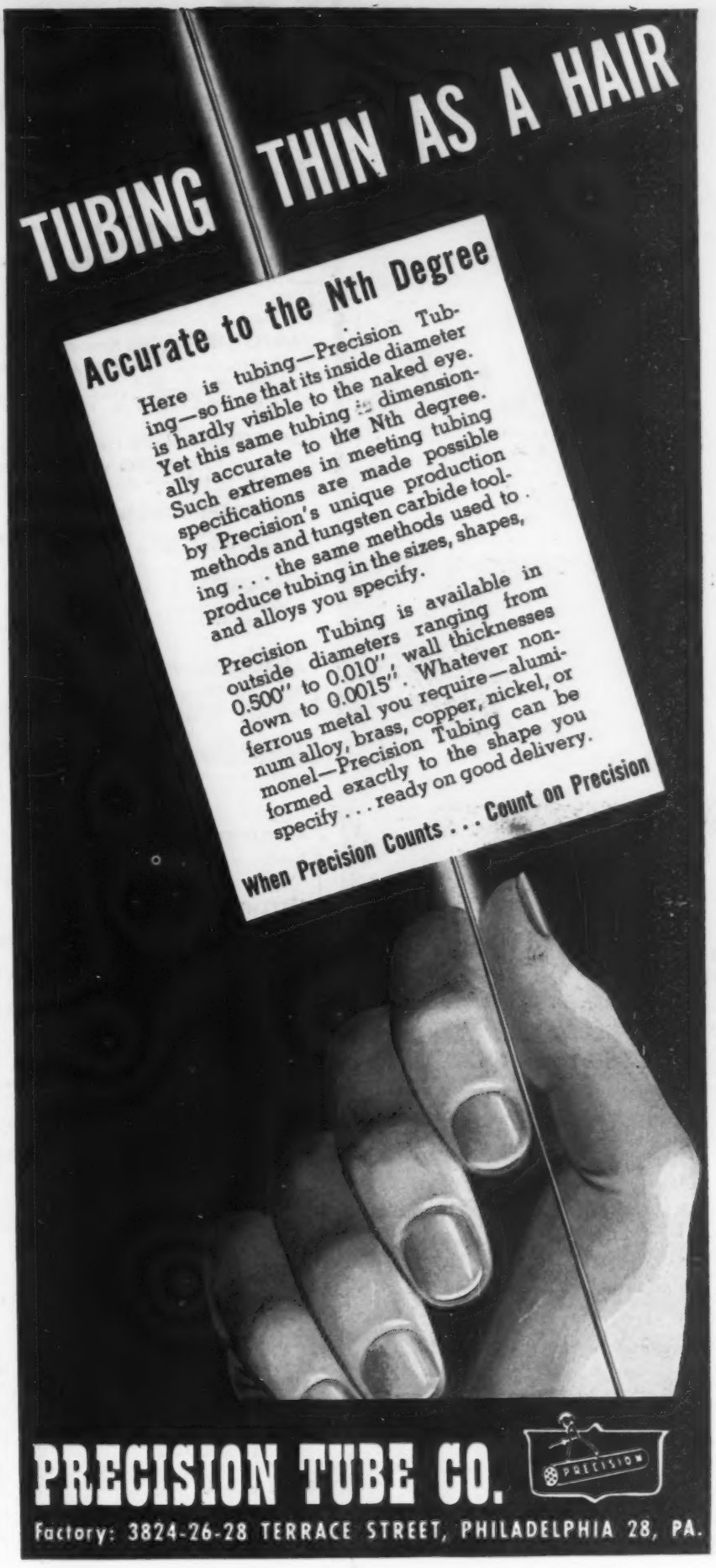
Waterproof Connectors. Cannon Electric Development Co., 3209 Humboldt St., Los Angeles 31, Calif. A new 6-page bulletin W-248 gives dimensional data on the three sizes of type W waterproof connectors, together with photos of underwater geophysical applications. These plugs and receptacles are built to withstand pressures up to 250 pounds or approximately 550 ft underwater for all types of circuits in radio, sound, or power.

Electrical Connectors. Mines Equipment Co., Dept. 12, 4215 Clayton Ave., St. Louis 10, Mo. Bulletin MC108 illustrates and describes in detail a line of molded neopreme rubber electrical connectors and associated equipment. Products are identified by short three-letter symbols. Tabular index is included.

Cylindrical Capacitors. Cornell-Dubilier Electric Corp., South Plainfield, N. J. Descriptive bulletin NB-105 treats of the compact cylindrical-type capacitors, RC-111 and RC-112. Ratings are 0.005 μf at 6,000 volts d-c and 0.05 μf at 6,000 volts d-c, respectively. They are designed for safe operation from −55 to +100 C, are hermetically sealed, and Dykanol impregnated and filled.

Technician's Catalog. Walter L. Schott Co., 9306 Santa Monica Blvd., Beverly Hills, Calif. The 1948 catalog lists and describes a complete line of hardware, chemicals, tools, finishing materials, and service items for the electronic technician. Prices are included.

Insulation Tester. Herman H. Sticht Co., Inc., 27 Park Place, New York, N. Y. Illustrations, general description, outstanding features and specifications of the Minor Megohmer insulation tester are found in bulletin 450. The portable instrument weighs three pounds. It has a d-c generator with a 500-volt d-c output, and measures up to 50 megohms.


TUBING THIN AS A HAIR
Accurate to the Nth Degree
Here is tubing—Precision Tubing—so fine that its inside diameter is hardly visible to the naked eye. Yet this same tubing is dimensionally accurate to the Nth degree. Such extremes in meeting tubing specifications are made possible by Precision's unique production methods and tungsten carbide tooling . . . the same methods used to produce tubing in the sizes, shapes, and alloys you specify.
Precision Tubing is available in outside diameters ranging from 0.500" to 0.010", wall thicknesses down to 0.0015". Whatever nonferrous metal you require—aluminum alloy, brass, copper, nickel, or monel—Precision Tubing can be formed exactly to the shape you specify . . . ready on good delivery.
When Precision Counts . . . Count on Precision
PRECISION TUBE CO.
PRECISION
Factory: 3824-26-28 TERRACE STREET, PHILADELPHIA 28, PA.

Designed for

M

Application

The No. 69040 Series
of
PERMEABILITY TUNED CERAMIC FORMS

In addition to the popular shielded plug-in permeability tuned forms, 74000 series, the 69040 series of ceramic permeability tuned unshielded forms are available as standard stock items. Winding diameters and lengths of winding space are 13/32 x 7/32; 1/4 x 3/8; and 1/2 x 1 1/16, for the 69041, 69043 and 69045 respectively. Nos. 69043 and 69046 have powdered iron slugs while Nos. 69041 and 69045 have copper slugs.

JAMES MILLEN MFG. CO., INC.

MAIN OFFICE AND FACTORY
MALDEN
MASSACHUSETTS

M

Additions and Corrections

PRODUCT LISTINGS

The following listings are to be used in conjunction with the June 1948-1949 ELECTRONICS BUYERS' GUIDE for information on manufacturers' names, addresses and products omitted or incorrectly listed in that issue.

AMPLIFIERS—*Audio Frequency*
Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.
Planet Radio Mfg. Corp., 6508 Euclid Ave., Cleveland 3, Ohio

AMPLIFIERS—*Audio Input Systems*
Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.

AMPLIFIERS—*Decade*
Keithly Instrument Co., 1508 Crawford Road, Cleveland 6, Ohio

AMPLIFIERS—*Facsimile*
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

AMPLIFIERS—*Peak Limiting*
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

AMPLIFIERS—*Photocell*
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

AMPLIFIERS—*Wideband*
Tel-Instrument Company, Inc., 50 Paterson Ave., East Rutherford, N. J.

ANTENNAS—*Television*
Intra-Video Corp. of America 851 Madison Ave., New York 21, N. Y.

ATTENUATORS
Shallcross Mfg. Co., 10 Jackson Ave., Collingdale, Pa.

CAPACITORS—*Oil Impregnated*
Crown Capacitor Corp., Minot & Depot Sts., Wrentham, Mass.

CAPACITORS—*Paper Tubular*
Crown Capacitor Corp., Minot & Depot Sts., Wrentham, Mass.

CAPACITORS—*Wax Impregnated*
Crown Capacitor Corp., Minot & Depot Sts., Wrentham, Mass.

CHOKES—*Filter*
Empire Coil Co., Inc., 238 Huguenot St., New Rochelle, N. Y.

COIL ASSEMBLIES
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Antenna*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Choke*
Empire Coil Co., Inc., 238 Huguenot St., New Rochelle, N. Y.
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Magnet*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Multiple Wound*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Pickup*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Power & a-f Coils & Windings*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*r-f & i-f Receiving & Transmitting*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Relay & Solenoid*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Television Focusing*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COILS—*Transformer Coils & Windings*
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.

COMMUNICATION SYSTEMS — *Facsimile*
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

CONNECTORS—*Cable Connectors & Couplings*
Electro-Connector Corp., 110 W. Oxford St., Phila. 22, Pa.

CONTROLS—*Alarm System*
Photobell Company, 116 Nassau St., New York 7, N. Y.

CONTROLS—*Counter*
Photobell Company, 116 Nassau St., New York 7, N. Y.

CONTROLS—*Fluid Conductivity*
General Controls Co., Glendale, California

CONTROLS—*Inspection*
Photobell Company, 116 Nassau St., New York 7, N. Y.

CONTROLS—*Photoelectric*
Photobell Company, 116 Nassau St., New York 7, N. Y.

CONTROLS—*Skew*
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio
(Continued on page 247)

ADDITIONS AND CORRECTIONS (continued)

RECEIVERS—*a-m/f-m Communication*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

RECEIVERS—*f-m*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

RECEIVERS—*Fixed Frequency*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

RECEIVERS—*Police & Fire*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

RECEIVERS—*Television*

Shevers Inc., Harold, 33 W. 46th St., New York 19, N. Y.
Tele King Corp., 601 W. 26th St., New York 1, N. Y.
Telicor Corp., 851 Madison Ave., New York 21, N. Y.

RECEIVERS—*uhf*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

RECEIVERS—*vhf*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

RECEIVERS, HOME—*a-m/f-m Combinations*

Shevers Inc., Harold, 33 W. 46th St., New York 19, N. Y.

RECORDERS—*Facsimile*

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

RECORDERS—*Film*

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

RECTIFIERS—*Dry Disc*

Electronic Controls Co. of New York, 3124 Avenue I, Brooklyn 10, N. Y.

RESISTORS—*Temperature Sensitive*

Carborundum Co., Globar Div., Niagara Falls, N. Y.

RESISTORS—*Voltage Sensitive*

Carborundum Co., Globar Div., Niagara Falls, N. Y.

SCANNERS—*Reflected & Transmitted Light*

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

SOCKETS—*Tube*

Electro-Connector Corp., 110 W. Oxford St., Phila, 22 Pa.

SOUND SYSTEMS—*Complete*

Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.
Planet Radio Mfg. Corp., 6508 Euclid Ave., Cleveland 3, Ohio

STANDARDS—*Frequency*

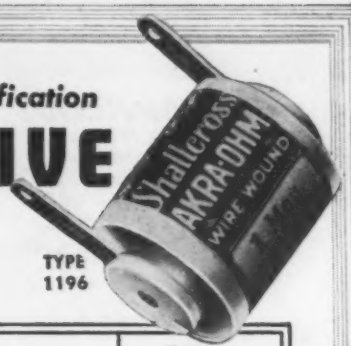
Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

STANDARDS—*Laboratory Time*

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

Joint Army-Navy R93 Specification

COMPARATIVE DATA



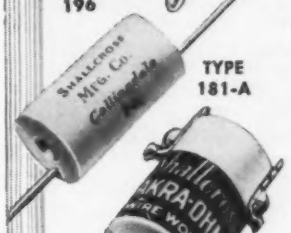
TYPE 1196

JAN Style Numbers RB	JAN Power Ratings Watts	Shallcross Type Numbers	Shallcross Power Ratings Watts
RB10	0.25	173	0.25
		176*	0.25
RB11	1/3	183	0.5
		183-A	0.5
		186*	0.5
RB12	0.5	193*	1.0
RB13	0.5	196	1.0
		1196**	1.0
RB14	1.0	116	2.0
	1.0	1110**	2.0
RB20	0.75	100	1.0
RB21	Suggest JAN 20 or JAN 22		
RB22	1.5	110	2.0
RB40	0.4	120	0.25
RB41	0.5	140	0.5
RB42	0.6	160	1.0
RB51	0.25	181-A	0.5

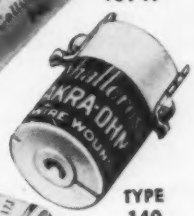
NOTE: * Indicates Maximum JAN Dimensions.
** Indicates Hermetically Sealed Resistor.

TYPE 100

TYPE 196



TYPE 181-A

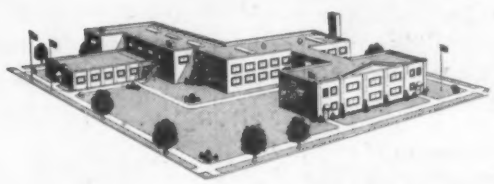


TYPE 140

TYPE 173

JAN R93 and SHALLCROSS Akra-Ohm Accurate Fixed Wire Wound RESISTOR TYPES

Write today for Shallcross Resistor Engineering Bulletin R giving full details on Akra-Ohm Resistors for every need and including mounting and terminal designs; dimensions; power dissipation; resistance alloys; moisture and fungus-proofing and hermetic sealing data; temperature coefficient of resistance and maximum resistance charts.



SHALLCROSS MFG. CO.

Engineers • Designers • Manufacturers

DEPT. E-108, COLLINGDALE, PA.

Announcing

A New Product by

Chicago Condenser Corporation

We have been licensed to manufacture

Fabricated Plate Electrolytic Condensers

For all purposes

We are now ready to supply your needs

Your specifications for quotations will be given prompt attention

Chicago Condenser Corporation

3255 West Armitage Ave. • Chicago 47, Ill.

POWDERED METAL CORES

PyroFerric's

EXCLUSIVE SPECIALTY

Since 1933 PYROFERRIC has been the standard source for IRON CORES manufactured to desired permeability, frequency, "Q", resistance and physical strength . . . to fit any circuit.

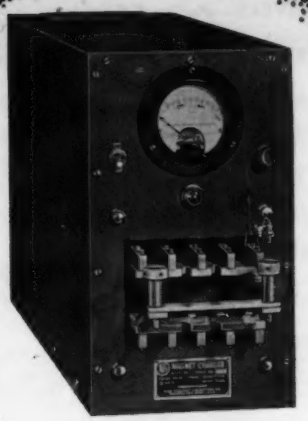
PYROFERRIC, with its background of research and experience, will gladly consult with you on your IRON CORE requirements.

PYROFERRIC CO.

621 EAST 216 ST., NEW YORK 67, N. Y.

TO CHARGE MAGNETS!

ECONOMICALLY!
EFFICIENTLY!
QUICKLY!
SAFELY!



MORE AND MORE COMPANIES ARE ADOPTING THE RFL MODEL 107 CHARGER

This portable, packaged unit will charge all kinds and shapes of magnets. Unique "flux-guide" fixtures developed by our engineers take full advantage of the charging current and accommodate multipole and oddly shaped magnets.

The charger weighs 75 pounds, can be moved about, and saves much valuable space. Plugging into any 110 volt AC outlet, it is completely safe and simple to operate for production charging by unskilled personnel.

The descriptive folder, **E-10,** gives complete information on the charger, shows typical fixtures and lists some of the many manufacturers, airlines, repair services and laboratories who use the Model 107. Write for this folder today and feel free to outline your magnet charging problems without obligation.

RADIO FREQUENCY LABORATORIES, INC.

Boonton, New Jersey

ADDITIONS AND CORRECTIONS (continued)

SWITCHES—*Mercury*

General Electric Co., Tube Div., Schenectady 5, N. Y.

SYNCHRONIZERS—*Electronic*

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

TELEVISION SYSTEMS—*Industrial*

Telicor Corp., 851 Madison Ave., New York 21, N. Y.

TESTERS—*Microwave Radar Testing Equipment*

Technicraft Laboratories, Inc., Box 1908, Waterbury, Conn.

TOOLS—*Soldering Guns*

Weller Mfg. Co., 806 Packer St., Easton, Pa.

TRANSFORMERS—*Microwave*

Technicraft Laboratories, Inc., Box 1908, Waterbury, Conn.

TRANSMITTERS—*f-m*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*Facsimile*

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio

TRANSMITTERS—*Fixed Frequency*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*Fixed Station Communication*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*Portable and Mobile Radio-Telephone*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*Pulse Time Modulation*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*Radio Range*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*uhf*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TRANSMITTERS—*vhf*

National Electronics Laboratories, Inc., 200 King St., Alexandria, Va.

TUBE PARTS

Bases

General Electric Co., Tube Div., Schenectady 5, N. Y.

Caps

General Electric Co., Tube Div., Schenectady 5, N. Y.

Cathode Sleeves & Tubes

General Electric Co., Tube Div., Schenectady 5, N. Y.

Increased production permits PICKERING *to announce . . .*

NEW · LOW · PRICES

PICKERING reproducers have always been built to the highest standards of the critical listener willing to pay a premium for excellence in record reproduction.

The growing demand for Pickering quality and the resulting increase in production have made possible substantial price reductions.

Revised manufacturing techniques have enabled us to actually improve quality and lower prices at the same time.

We take great pleasure in giving our customers the benefit of lower production costs.

Model S-120M
with .0027" Sapphire Stylus
Former List Price—$25.00
Now $16.50

Model D-120M
with .0025" Diamond Stylus
Former List Price—$60.00
Now $41.50

NEW . . . to the line of Pickering Cartridge Reproducers is the Model D-140S for the new long playing, MICROGROOVE type disc recordings. The D-140S has a diamond stylus of .001" radius, tracks with a pressure of 5 grams and, like all Pickering Cartridges, incorporates all of the known requirements for perfect tracking, minimum record and stylus wear, and distortion-free reproduction.

Pickering & Company, Inc.

Model D-140S with .001" Diamond Stylus $60.00 List

Oceanside, Long Island, N. Y.

THE NEW
NATIONAL HFS
$125
(power supply extra)

Complete Coverage 27 mcs-250 mcs!

Covers all mobile communication services, as well as fixed services. Receives CW, AM OR FM! Superheterodyne with superregenerative 2nd detector.

Mobile, Portable or Fixed!

Operates from standard 110 volt, 60 cycle National 5886 power supply, National 686S 6-volt vibrator-type power supply or batteries! Built-in speaker. Light.

See your nearest National dealer listed in the classified section of your 'phone book.

National
EST. 1914
NATIONAL COMPANY, Inc.
MALDEN, MASSACHUSETTS

ADDITIONS AND CORRECTIONS (continued)

Cathode Ray Tube Side Contacts

General Electric Co., Tube Div., Schenectady 5, N. Y.

Grids and Supports

General Electric Co., Tube Div., Schenectady 5, N. Y.

Heat Radiators

General Electric Co., Tube Div., Schenectady 5, N. Y.

Metal Supports

General Electric Co., Tube Div., Schenectady 5, N. Y.

Mica Supports

General Electric Co., Tube Div., Schenectady 5, N. Y.

Water Jackets

General Electric Co., Tube Div., Schenectady 5, N. Y.

Wire Parts

General Electric Co., Tube Div., Schenectady 5, N. Y.

TUBES—*Phototubes and Photocells*

American Scientific Co., P. O. Box 1, High Bridge Station, New York 52, N. Y.

WASHERS—*Metal*

Sheffco Mfg. Co., 116 W. Ruby Ave., Palisades Park, N. J.

WAVEGUIDES—*Flexible*

Technicraft Laboratories, Inc., Box 1908, Waterbury, Conn.
Titeflex, Inc., 410 Frelinghuysen Ave., Newark 5, N. J.

WAVEGUIDES—*Rigid*

Technicraft Laboratories, Inc., Box 1908, Waterbury, Conn.

WIRE—*Fine Wire Specialties*

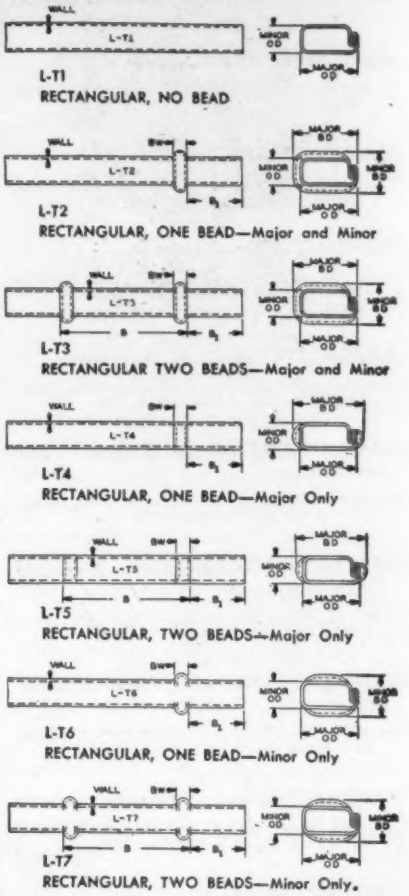
Sheffco Mfg. Co., 116 W. Ruby Ave., Palisades Park, N. J.

NAMES and ADDRESSES ADDITIONS and CORRECTIONS

Acme Telectronix, Div. of NEA Service Inc., West Third and Lakeside, Cleveland 13, Ohio
Allied Radio Corp., 833 W. Jackson Blvd., Chicago 7, Ill.
American Scientific Co., P.O. Box 1, High Bridge Station, New York 52, N. Y.
De Jur-Amsco Corp., Northern Blvd. at 45th St., Long Island City 1, N. Y.
Electro-Connector Corp., 110 W. Oxford St., Phila. 22, Pa.
Electronic Controls Co. of New York, 3124 Avenue I, Brooklyn 10, N. Y.
Electronic Instrument Co., Inc., 377 Blake Ave., Brooklyn, N. Y.
Filtron Co., The, 38-25 Bell Blvd., Bayside, Long Island, N. Y.
Fugle-Miller Laboratories, 398 Main St., Metuchen, N. J.
General Electric Co., Tube Div., Schenectady 5, N. Y.
Hansen Mfg. Co., Inc., Princeton, Indiana
Intra-Video Corp. of America, 851 Madison Ave., New York 21, N. Y.
Kurman Electric Co., Inc., 35-18 37th St., Long Island City 1, N. Y.
Microtone Company, The, 4602 Nicollet Ave., Minneapolis 9, Minn.
Photobell Company, 116 Nassau St., New York 7, N. Y.
Planet Radio Mfg. Corp., 6508 Euclid Ave., Cleveland 3, Ohio
Sheffco Mfg. Co., 116 W. Ruby Ave., Palisades Park, N. J.
Shevers Inc., Harold, 33 W. 46th St., New York 19, N. Y.
Technicraft Laboratories, Inc., Box 1908, Waterbury, Conn.

The latest—
LOCKSEAM* RECTANGULAR NICKEL CATHODES

Here are the "new shapes", in which *Superior* Lockseam* nickel cathodes are available. Full information on dimensions, tolerances and materials will be supplied upon request.



For other electronic and non-electronic tubing applications, use Superior Seamless and WELDRAWN†—and save!

Superior
THE BIG NAME IN SMALL TUBING (.010" TO 5/8" O.D. MAX.)

SUPERIOR TUBE CO.
ELECTRONICS DIVISION
2500 Germantown Avenue
Norristown, Pa.

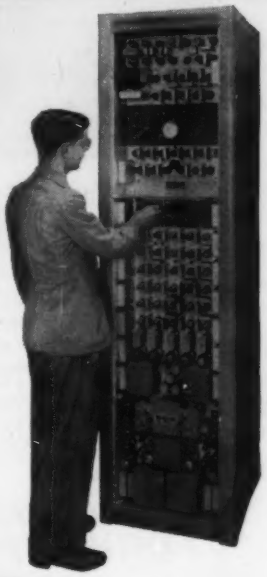
*Superior Tube Co. Patents
†Reg. U. S. Trade Mark

For Superior tubing on the West Coast, call PACIFIC TUBE COMPANY, 5710 Smithway Street, Los Angeles 22, Calif. ANgeles 2-2151.

POLARAD
TELEVISION *Equipment*

for studio • laboratory • manufacturer

SYNCHRONIZING GENERATOR
Model PT 101—Television



FEATURES
- Built-in 3" oscilloscope with synchronized sweeps for viewing Timing and Video Output pulse wave forms.
- Synchronized marker system for checking pulse width and rise time.
- Extreme stability, insured by deriving all pulses from leading edge of master oscillator pulse.
- Means for checking synchronizing pulses in odd and even fields.

SPECIFICATIONS
525 line, interlaced, 60 fields, 30 frames, RMA Synchronizing pulses held to tolerance specified in the NBTPB report of 1945. Output Pulses: Synchronizing, Video Blanking, Camera Blanking, Horisontal Driving, Vertical Driving Pulses. 5 volts across 100 ohm termination. Dual output jacks. 115 volts 50/60 cps. Complete with tubes.

TELEVISION MONOSCOPE SIGNAL SOURCE
Model PT 102

- Composite Video Signal
- Wide Band Video Amplifier, 6 DB down at 10MC
- Dual outputs for feeding two 75 or 100 lines
- Black positive or Black negative output
- Resolution greater than 600 lines

INPUT: Vertical and Horizontal Driving pulses. Camera and Kinescope Blanking Pulses.

OUTPUT: Composite Video Signal, 3 volts, 100 ohm line 115 volts 50/60 cps. Complete with tubes and including high and low voltage power units.

9 FERRY STREET
NEW YORK 7, N. Y.

Polarad *Electronics Company*

Television engineers and consultants to the nation's great television stations.

THIS SELF-LOCKER *won't* SHAKE LOOSE!

UNBRAKO
Reg. U.S. Pat. Off.

Pat'd. and Pat's. Pend.

The Knurling of this "Unbrako" Socket Set Screw, as shown, "swages the threads", so that it becomes a most excellent "Self-Locker" . . . for use with the 5 standard points that do not lend themselves to knurling. This "Unbrako" Socket Set Screw positively *will not shake loose*, regardless of the most chattering vibration. Sizes available from #4 to 1½" diameter, and in a full range of lengths. Ask for your copy of the "Unbrako" Catalog . . . it is useful and informative.

Our patented "Unbrako" Self-Locking Knurled Socket Set Screws and Stripper Bolts lock in most any industrial screw application. They *won't shake loose*. Millions and millions in use.

Write us for the name and address of your nearest "Unbrako" Industrial Distributor and your copy of the "Unbrako" Catalog.

OVER 45 YEARS IN BUSINESS

Knurling of Socket Screws originated with "Unbrako" in 1934.

STANDARD PRESSED STEEL CO.

JENKINTOWN, PENNA. **BOX 596**

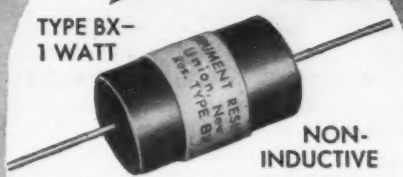
CHICAGO • DETROIT • INDIANAPOLIS • ST. LOUIS • SAN FRANCISCO

—high accuracy plus!

For Instrumentation and other critical applications

IN-RES-CO wire wound resistors are engineered for the manufacturer maintaining a reputation of top quality and performance in his equipment. They cover a full range from 1 watt to 10 watts and .01 ohm to 1.5 megohm. Conservative ratings assure maximum long life; trouble free service. Write for catalog today on company letterhead.

TYPE BX—1 WATT



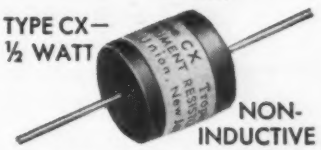
NON-INDUCTIVE

MAX. RES: 1.5 Megohm (331 Alloy)
1.0 Megohm (Nichrome)
30,000 Ohms (Manganin)

BODY SIZE: 1" lg. by 9/16" diam.

TOLERANCE: STANDARD 1%
(TO 1/10% at Slight Extra Cost)

TYPE CX—½ WATT



NON-INDUCTIVE

MAX. RES: 750,000 ohm (331 Alloy)
500,000 ohm (Nichrome)
15,000 ohm (Manganin)

BODY SIZE: 5/8" lg. by 9/16" diam.

TOLERANCE: STANDARD 1%
(TO 1/10% at Slight Extra Cost)

IN-RES-CO
APPLICATION-DESIGNED
RESISTORS
IN-RES-CO

INSTRUMENT RESISTORS CO., 1056 COMMERCE AVE., UNION, N. J.

For LONG TROUBLE-FREE OPERATION Specify

N·W·L

CUSTOM-BUILT TRANSFORMERS

AND ELECTRICAL COILS

Over 25 years' experience in the manufacture of specials at cost that compares favorably with standard types. Built-in quality proved by years of actual use.

From 10VA to 300 KVA Dry-Type Only, Both Open and Encased, 1, 2, & 3 Phase 15 to 400 Cycles.

PROMPT DELIVERIES!

NOTHELFER
WINDING LABORATORIES
9 ALBERMARLE AVE., TRENTON 3, N. J.

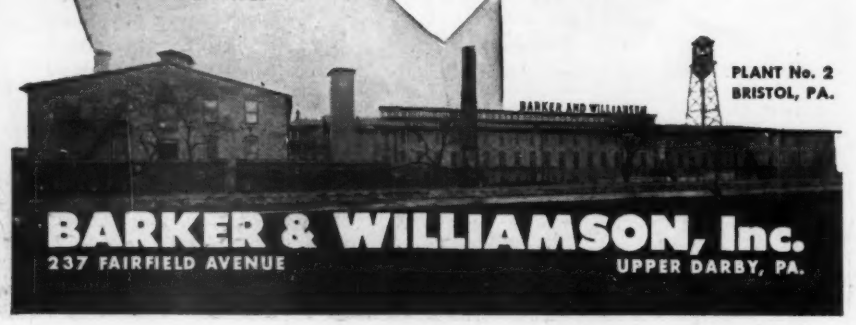
IF IT'S ELECTRONIC . . .
B&W CAN MAKE IT FOR YOU!

NOW IN PRODUCTION AT B & W

COMPLETE RADIO TRANSMITTERS • DUAL DIVERSITY CONVERTERS, CONTROL UNITS and FREQUENCY SHIFT EXCITERS FOR RADIO TELETYPE TRANSMISSION • SPECIAL TEST EQUIPMENT • REDESIGN, MODERNIZATION AND MODIFICATION OF EXISTING EQUIPMENT • MACHINE WORK • METAL STAMPING • COILS • CONDENSERS • OTHER ELECTRONIC DEVICES IN A WIDE RANGE OF TYPES

From small electronic components up to carefully engineered test equipment and complex electronic devices, Barker & Williamson can engineer and manufacture high quality products to your specifications.

Three B&W plants, comprising 150,000 square feet, completely equipped with a competent engineering staff, machine shop, tool room (including all machines for drilling, milling, turning, stamping and forming metals and plastics), and a complete woodworking shop are at your disposal. Your inquiries are welcome. Write Department EL-108 for prompt reply.



PLANT No. 2
BRISTOL, PA.

BARKER & WILLIAMSON, Inc.
237 FAIRFIELD AVENUE UPPER DARBY, PA.

ADDITIONS AND CORRECTIONS (continued)

Tele King Corp., 601 W. 26th St., New York 1, N. Y.
Telicor Corp., 851 Madison Ave., New York 21, N. Y.
Tel-Instrument Co., Inc., 50 Paterson Ave., East Rutherford, N. J.
Weller Mfg. Co., 806 Packer St., Easton, Pa.

TRADE NAMES ADDITIONS and CORRECTIONS

AMERTRAN
American Transformer Co.

DURATIP
Weller Mfg. Co.

EMPIRE
Empire Coil Company, Inc.

FLEXITIP
Weller Mfg. Co.

INDUSTRIAL TELECEIVERS
Industrial Television, Inc.

KNIGHT
Allied Radio Corp.

MULTIVIDEO
Industrial Television, Inc.

SOLDERLITE
Weller Mfg. Co.

SPEED IRON
Weller Mfg. Co.

SYNCHRON
Hansen Mfg. Co., Inc.

TECH LAB
Tech Laboratories, Inc.

TELEPHOTO
Acme Telectronix, Div. of NEA Service Inc.

Due to an error, the listings of the General Controls Co. of Glendale, California incorrectly referred to an advertisement on page 111 which was an advertisement of the General Control Company, 1204 Soldiers Field Road, Boston 34, Mass. There is no connection between the two companies.

Due to an error, the listings of the Northern Radio Co., 314 Bell St., Seattle 1, Wash. incorrectly referred to an advertisement on pages 190 and 191 which was an advertisement of Northern Radio Co., Inc., 143-145 W. 22nd St., New York 11, N. Y. There is no connection between the two companies.

Electronic Controls Co. of New York advertisement incorrectly listed as Page 224 instead of Page 244.

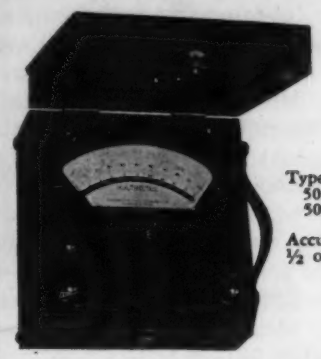
Manufacturers of glass bonded mica were incorrectly listed, they should have only included the following:

Electronics Mechanics, Inc.,
70 Clifton Blvd.,
Clifton, N. J.

General Electric Co.,
Chemical Dept.,
Pittsfield, Mass.

Mycalex Corp. of America,
60 Clifton Blvd.,
Clifton, N. J.

RAWSON METERS



Types:
501A
501C

Accuracy
½ of 1%

MULTIMETERS and REGULAR METERS
AC and DC types, high accuracy, multiple ranges, 2 microamperes to 1 ampere DC. 2 milliamperes to 3 amperes AC.

ELECTROSTATIC VOLTMETERS
Ranges 150-v. to 35,000-v. AC or DC. Resistance exceeds million megohms. Can measure static electricity.

FLUXMETERS
Laboratory and production measurements on magnets and magnetic circuits. Single push button return-to-zero.

WATTMETERS
High sensitivities, low power factors. New types soon to be announced.

Special apparatus built to order

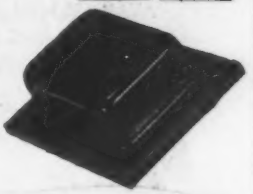
RAWSON ELECTRICAL INSTRUMENT COMPANY

111 Potter St. Cambridge, Mass.

Representatives

Chicago Los Angeles New York City

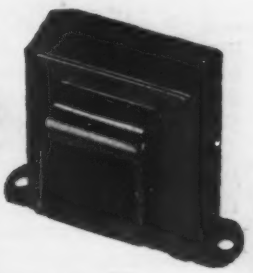
KOBZY *Quality*
GETS WIDE APPROVAL . .

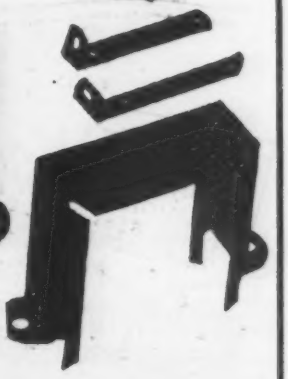


LAMINATIONS . . HOUSINGS . . CONTACTS . . LUGS
MISCELLANEOUS METAL STAMPING PARTS . . . .

Here is the quality that comes from years of experience and modern facilities. We work very closely with our customers, designing to their specifications. Our mechanical engineering department is able to tool up for special parts. Put your needs up to us for entirely satisfactory results.

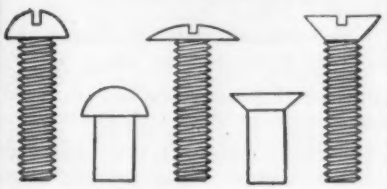
Send for your copy of our new catalog.





K O B Z Y
TOOL COMPANY
1539 DAYTON ST. CHICAGO 22, ILL.

PROMPT DELIVERY!
Stainless Steel MACHINE SCREWS and Rivets



SCREWS, nuts, washers, pins — Allmetal carries the largest stock in the country of stainless steel fasteners and screw machine parts. Our complete facilities for heading, tapping, drilling, reaming, slotting, turning, stamping, broaching and centerless grinding make possible prompt delivery of specials, too. Write for our free 83-page catalog today.

We also carry:

Cap Screws	Nuts	Taper Pins
Bolts	Socket Screws	Cotter Pins
Washers	Wood Screws	Pipe Fittings

Send for FREE CATALOG

Allmetal Screw Products Co., Inc.
33 Greene Street, New York 13, N. Y.

Now you can have
*DYNAMIC NOISE SUPPRESSION
with Your Present Radio-phonograph or Amplifier

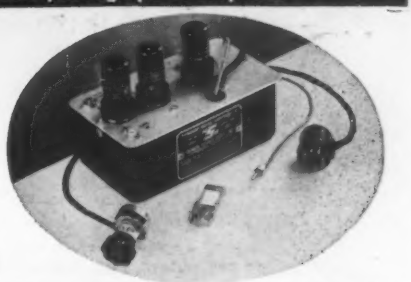
These 3 simple steps add realism to your music reproduction.

1. Plug in the *"Little Wonder"* *Dynamic Noise Suppressor between your pick-up and amplifier.
2. Plug in the socket adapter to the power-tube socket.
3. Insert the matched low-needle-talk pick-up in your pick-up arm.

That's all that is necessary to reduce background noise with negligible loss of depth and brilliance . . . giving you a gratifying sense of "presence" in your music reproduction.

LOW PRICE . . . . . $82.50 list

Includes tubes, matched pick-up, remote control, cables, fittings, adapters, instructions.



The remote control, for setting the exact degree of suppression you find most pleasing, can be mounted wherever you wish . . . at the instrument or even in another part of the room. The 3-tube suppressor unit can be placed anywhere in the cabinet.

The *"Little Wonder"* realizes the full capabilities of your present equipment; can be used, with suitable pick-up, on the new, long-playing records, too. For full specifications, write Dept. EL. Or, even better, hear a demonstration at your distributor's.

*Licensed under U.S. and foreign patents pending and issued.

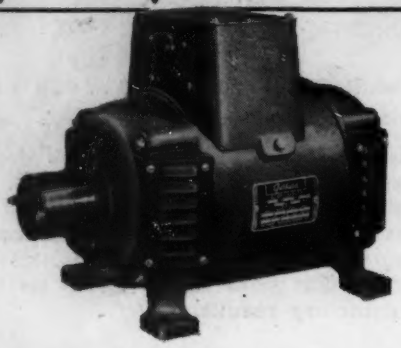
HERMON HOSMER **SCOTT, INC.**
"PACKAGED ENGINEERING"
385 PUTNAM AVE. • CAMBRIDGE 39, MASS.

Automatic Frequency Control

on DC to AC CONVERTERS

AVAILABLE IN 22 TYPES AND 3 FRAME SIZES BY

Gothard



DC to AC Rotary Converters having Automatic Frequency Control are now being offered in all models. Input voltages from 6 to 230 V DC; output: 110 to 1000 VA at 60 cycles, 90 to 800 VA at 50 cycles.

Write today for illustrated catalog #48 on: DYNAMOTORS CONVERTERS GENERATORS

SPECIALLY DESIGNED for Television Sets, AC Radios, Radio-Phonographs and Recorders. For use where the power source is direct current: such as ships, vehicles, trains, office buildings, and urban DC areas.

GOTHARD Manufacturing Co.

2114 Clear Lake Ave. Springfield, Illinois

Export Division: 25 Warren St. New York 7, N. Y.

DECALS
Decimeter Decals provide the newest, most convenient and economical method for marking electronic equipment.
They are easy to apply—no holes to drill—and they adhere to any surface, including wrinkle and crackle finishes. Decals often fit spaces too small for other types of marking. Decimeter Decals are inexpensive—a wide assortment can be stocked for low cost.
Decimeter Decals are printed in neat, opaque letters in a tough, clear protective coating of outstanding durability. They have a high degree of resistance to wear and abrasion. Over 275 different decals are available, including television titles, dial plates, radio titles, call letters and high-voltage signs for safety. Decimeter Decals are of the self-adhering "slip-off" type, and require no cement.
Speedy application plus the low cost of individual Decimeter Decals mean substantial savings in marking any type of electronic equipment. Write for folder 4B which lists complete line available and net prices. We will also enclose handy order form for your convenience in selecting your own assortment.
DECIMETER
1430 MARKET ST. INC. DENVER 2, COLO

and point-to-point communications for the rapidly expanding civil aviation services and for administrative, public and meteorological traffic. The new system will operate throughout Kenya, Uganda and Tanganyika.

Two of the latest types of Marconi transmitters have been chosen for the service: type TGS. 541—a 200-watt transmitter with a frequency range of 1.5 to 23 mc; and type TGS. 501—a 100-watt set covering the 1.5 to 13-mc range. Special features include crystal control with provision for rapid selection of any one of six working frequencies.

Australia's Rural Radiophone

FIRST INSTALLATIONS are now being made in the Broken Hill district in New South Wales, of a radiophone set which will link Australian ranchers to the telephone network. The equipment was developed by the research laboratories of Electronics Industries Ltd., Melbourne, in cooperation with the Commonwealth Postmaster General's Department.

The subscriber merely lifts a standard telephone handset from the instrument and depresses a key to connect him with the operator. Calls are accepted for any point in Australia and most overseas countries.

The base station transmitter is amplitude-modulated and has an output of 200 watts. It covers subscribers within a range of 200 miles. Subscriber sets are operated from a 12-volt storage battery and transmission is also by a-m.

Automatic Control Course

INSTRUMENTATION FOR the process industries will be the subject matter of a third short course to be conducted by Texas A & M College in cooperation with several industrial concerns at College Station, Texas, October 26-28. Manufacturers of instruments and automatic controls are participating by showing educational exhibits.

The program will be of special value to instrument, process design

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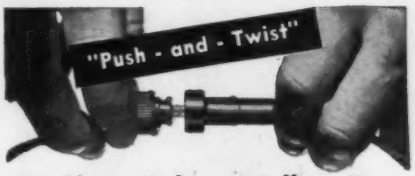
QUALITY COILS
TO
YOUR SPECIFICATIONS

We manufacture quality coils for the radio and electronics industry. Universal, bank-wound, universal-progressive or solenoid coils made to JAN specifications. Let us know your requirements: We will quote promptly.

FUGLE-MILLER LABORATORIES

METUCHEN NEW JERSEY
398 Main St. Me 6-2245



Littelfuse Makes Headline News with "In-Line" Fuse Retainer

Littelfuse's latest development: the "in-line" fuse retainer for fingertip ease in fusing. Precisely molded of high impact bakelite and designed primarily for low voltage applications: car radios, heaters, spot lights and other automotive trouble spots where a fool-proof easy-to-handle fuse installation is desired. The strongly spring-locked retainer opens with a "push-and-twist" of the finger tips. Inside, the fuse rests against knife-edged, cup contacts that assure greatest degree of contact with lowest voltage drop. Doubled wall thickness at juncture of shoulder and lower body.

Available for all standard automotive fuse sizes. Retainer may be had with or without wire leads and terminals, with or without fuses.

LITTELFUSE *Incorporated*
4760 N. RAVENSWOOD AVE., CHICAGO 40, U. S. A.
BITE-T-LITE • SWITCH-LITE • IGNITION FRITZ • NEON INDICATORS
SWITCHES • CIRCUIT BREAKERS • FUSES, MOUNTINGS AND ACCESSORIES

ULTRA SENSITIVE D. C. AMPLIFIER

An Electronic Replacement For Sensitive Galvanometer Systems

The Model 53 Breaker-type D.C. Amplifier was developed for the measurement of d. c. and low frequency a. c. voltage in the microvolt and fractional microvolt region. It is compact, portable, and makes an excellent replacement for the suspension galvanometer. The output of the amplifier is sufficient to operate standard meters and recording devices directly.

It has been employed for the amplification of infra-red detectors, thermocouples, voltaic photocells, and the like, both in research and industrial applications.

Among the advantages of this amplifier are the following:

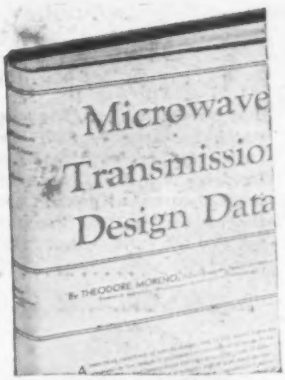
1. Noise level that approaches the theoretical limit imposed by Johnson noise.
2. Extremely low zero drift (less than .005 μ V after warmup).
3. Freedom from the effects of vibration such as found in moving vehicles.
4. Response characteristics permitting overall amplification flat from 0 to 10 cycles per second.
5. Reliability, as demonstrated by units which have been in continuous operation for several years.

THE PERKIN-ELMER CORPORATION

GLENBROOK • CONNECTICUT

For Complete Information Write Dept. 50.

A wealth of data to help you plan—design—construct MICROWAVE EQUIPMENT



HERE'S a goldmine of data that saves you time and effort —puts at your fingertips the *specific* material you want when you're planning, designing and constructing microwave equipment. This book is packed from cover to cover with authoritative reference data on coaxial lines and flexible cables—practical structures and components of wave guides —dielectric materials and their properties—cavity resonators, etc. . . . *all considered from the ultra-high-frequency point of view.*

Just published!

MICROWAVE TRANSMISSION DESIGN DATA

By THEODORE MORENO, Project Engineer, Sperry Gyroscope Company; Research Associate, Massachusetts Institute of Technology. 250 *pages*, 202 *illustrations*, $4.00

THIS book brings you vital information to aid you in the engineering design of all kinds of microwave equipment. It discusses briefly transmission line theory—from the high frequency point of view—then brings you the practical working data you need on the job. Over two hundred diagrams—graphs—charts—tables, etc., illustrate the text matter, making it clear and easy-to-follow. The material is concise—well-organized—useable . . . the kind of information an engineer must have to design a transmission system employing waveguides.

Read the chapter headings.

1. General Considerations for Microwave Transmission Lines
2. Attenuation, Impedance Matching, and Reflections on Transmission Lines
3. Impedance Relations on Transmission Lines
4. General Formulas for Coaxial Lines
5. Flexible Cables
6. Coaxial Line Structures and Transformers
7. General Formulas for Wave Guides
8. Attenuation in Wave Guides
9. Obstacles, Discontinuities, and Junctions
10. Miscellaneous Waveguide Structures
11. Wave Guides Filled with Dielectric Material
12. Dielectric Materials
13. Cavity Resonators

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McGRAW-HILL BOOK CO.,
330 W. 42nd Street, NYC 18

Send me Moreno's MICROWAVE TRANSMISSION DESIGN DATA for 10 days' examination on approval. In 10 days I will send $4.00, plus a few cents postage, or return the book postpaid. (Postage paid on cash orders.)

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and operating engineers. Lectures have been scheduled to cover such subjects as measurement and control of temperance, pressure, liquid level and time.

Registration fee is $5.00. Further information may be obtained by writing Professor P. G. Murdoch, Chemical Engineering Department, Texas A & M College, College Station, Texas.

Plan Radio Net for India

TO RELIEVE the overburdened telegraph system in India, a radio communications network covering the ten leading cities is due to be set up shortly. Official estimates are that initial cost will be about $1,300,000 and annual recurring costs about $210,000.

Each of the ten cities will have a 10-kw high-speed short-wave transmitter and a triple diversity receiver. Both will be teleprinter-equipped.

Radio License Increase

MORE THAN 635,000 separate radio authorizations, covering stations and operators, were outstanding with the FCC at the close of the fiscal year. This represents an increase of nearly 90,000 over the previous year. Breakdown is as follows:

	As of June 30, 1947	*As of June 30, 1948*
STATIONS		
Broadcast		
A-M	1,795	2,034
F-M	918	1,020
TV	66	109
TV (experimental)	81	124
Educational	38	46
International	37	37
Remote Pickup	583	571
Other	33	26
Totals	3,551	3,967
Nonbroadcast		
Aeronautical	15,843	20,858
Marine	10,755	15,024
Public Safety	4,257	4,903
Land Transportation	1,792	3,122
Industrial	1,571	2,855
Miscellaneous	1,919	1,648
Amateur	*75,000	78,434
Totals	112,137	126,844
OPERATORS		
Amateur	*80,000	77,923
Commercial	*325,000	*347,000
Aircraft	*25,000	79,924
Totals	430,000	504,847

* Estimated.

The station figures do not represent the actual number of transmit-

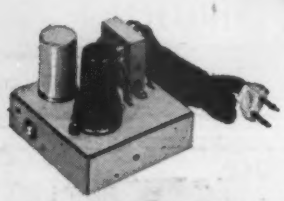
HARVEY HAS THE TOPS

FM TRANSLATOR
General Electric Model XFM-1

Post-war version of the old G.E. J.F.M-90 Translator which was used and enjoyed by tens of thousands of discriminating radio listeners.

Covers 88-108 mc range, dial 12 inches long, uses guillotine tuning for highest efficiency, high stability. Designed for export, has power inputs for 110 to 250 volts, 50/60 cy. Used in conjunction with good audio section or separate amplifier will provide best FM listening you ever heard. In attractive natural walnut cabinet — 10¾" high x 15¾" wide x 11⅜" deep, complete with 8 tubes. Tropic-proof construction. Quantity limited, no more available. Get your order in while they last!

Special price $49.50



GE PRE-AMPLIFIER

Just arrived in stock, the new GE Phonograph Pre-Amplifier with built-in power supply for use on 105-125 V. AC only. Does not use AC-DC type power circuit, has self-contained power transformer and is completely isolated from power line. For use with GE Variable Reluctance Cartridge.

Net $9.57

MICRO-GROOVE CARTRIDGE

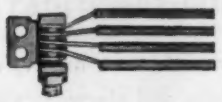
Get set to use those new micro-groove records. All you need is this new Pickering Diamond Point cartridge with the 1-mil stylus. Pickering cartridge fits your present arm. With this accurately-shaped diamond stylus you can play the new micro-groove records at once....**$36.00**

Telephone: LOngacre 3-1800

HARVEY RADIO COMPANY INC.
103 West 43rd St., New York 18, N. Y.

BRADLEY RECTIFIERS

INSTRUMENT RECTIFIERS
FOR BETTER A.C. SCALE



For really accurate determination of very low A.C. current—use Bradley "Coprox" instrument rectifiers. Especially designed for use where stability and permanence of calibration are important. Shown above: CX-2E Series. Vacuum-processed, gold-coated, full-wave bridge. Rated 4.5 volts A.C. 3 volts D.C. 5 milliamperes D.C.

PHOTO CELLS

SIMPLIFY PHOTO-ELECTRIC APPARATUS

Luxtron* photo cells convert light into electrical energy. No external voltage is required to operate meters and meter relays directly from Bradley photo cells, improving control over your processes, reducing your costs. Housed model shown. Many different sizes and shapes, mounted and unmounted.

*T. M. REG. U. S. PAT. OFF.

Our engineers will select or develop rectifiers or photo cells to meet your needs exactly. Write for BRADLEY LINE showing basic models.

BRADLEY LABORATORIES, INC.
82 Meadow St. New Haven 10, Conn.

Vital Aids TO

MANUFACTURERS OF MINIATURE TUBE RADIOS AND EQUIPMENT

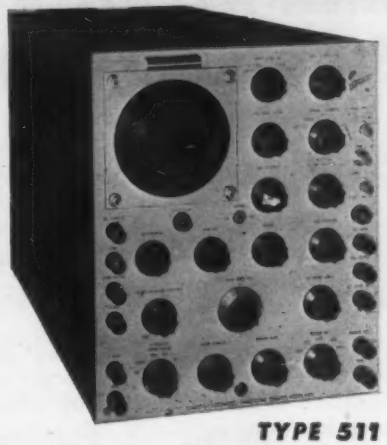
★ Star Miniature Socket Wiring Plugs for accurate alignment of miniature socket contacts during wiring. Precision cast of zinc base alloy—pins of stainless steel. #JE-9 (9 pin); #JE-10 (7 pin).

★ Star Miniature Tube Pin Straighteners (with stainless steel insert) to obtain a perfect fit when the tube is placed in the equipment. #JE-15 (9 pin); #JE-13 (7 pin).

Scientifically designed — Precision made
Immediate Delivery in Any Quantities

★STAR EXPANSION PRODUCTS CO., INC.
147 CEDAR STREET, NEW YORK 6, N. Y.

PROOF OF PERFORMANCE...



The fact that over 50% of the purchasers of the Tektronix Type 511 Oscilloscope have re-ordered additional instruments after having placed a Type 511 in service provides positive evidence of the usefulness and value of this instrument.

The above category of Type 511 users includes the foremost Universities, Nuclear Physics groups, Industrial and Governmental research organizations throughout the country. A list of those in your vicinity will be provided upon request.

TYPE 511 FEATURES

- Continuously variable sweep speed, 1/10 second to 1 microsecond (10 cm).
- Direct reading sweep speed indication.
- Sweep magnifier for any 20% of normal sweep.
- Triggered, recurrent or single sweeps.
- Vertical deflection sensitivity: 0.27V to 200V per cm. (peak to peak).
- Vertical amplifier band pass, 10 mc. 1 stage, 8 mc. 2 stages.
- Fully compensated for optimum transient response.
- Self contained, total weight 65 lbs.

Price $795.00 f.o.b. Portland

Your inquiry will bring more detailed information and name of the nearest Field Engineering Representative.

Phone, EAst 6197
Cables, TEKTRONIX

TEKTRONIX INC.

712 S. E. Hawthorne Blvd.
Portland 14, Oregon

TELEVISION
HIGH VOLTAGE METER
0 to 30 KV

AN ABSOLUTE MUST FOR TELEVISION WORK

METER SPECIFICATIONS

Voltage Range: 0-30 Kilovolts at 50,000 ohms per volt sensitivity. Measures high voltage circuits with very light loading.

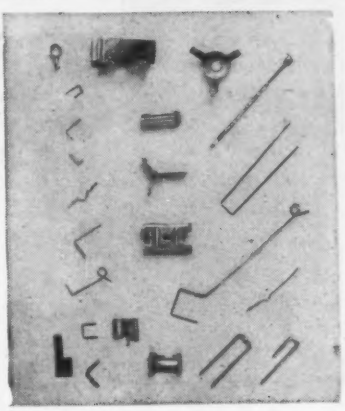
Polarity Reversing Switch: Permits measuring of positive or negative voltages from ground with maximum safety. Switch may be operated without arcing while the voltage is being applied. Off position of this switch locks the sensitive meter movement for transportation.

Special Terminals: Provided for oscilloscope connection to observe percentage of ripple, also waveform and frequency of ripple while checking voltage. The circuit used permits scope readings over an extremely wide frequency range.

A square cased 4" meter with an easy to read scale. Overall Size of Case: 7" wide, 9" long, 5" high. **Net Price** $67.50

Include 25% Deposit with Order, Balance C.O.D.

Pioneers in Projection Television
SPELLMAN TELEVISION CO., INC.
130 WEST 24th STREET • NEW YORK 11, N. Y.



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Long established electro-mechanical engineering organization is expanding its electronic department to include research and development on missiles, microwave systems, radar, communications, navigational devices, antennas, and associated equipment.

A few exceptional positions are open for top-flight senior engineers. Must have extensive experience on analysis of electronics systems, and ability to create new basic approaches to involved engineering problems. Commercial and university background desired. Please furnish complete resume, salary requirements and availability to: Personnel Manager

Engineering Division

W. L. MAXSON CORPORATION

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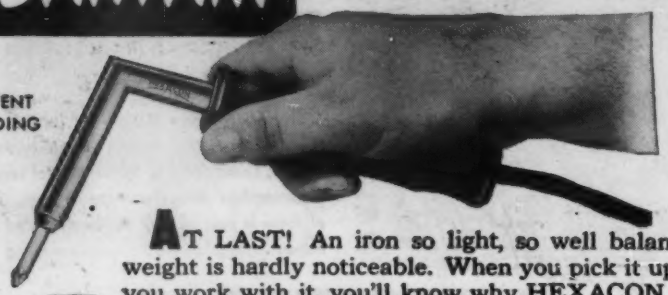
NEW! FEATHER WEIGHT BANTAM SOLDERING IRON

PATENT PENDING



AT LAST! An iron so light, so well balanced its weight is hardly noticeable. When you pick it up, when you work with it, you'll know why HEXACON calls it FEATHER WEIGHT. It's the perfect iron for long, delicate work where fatigue works against quality. It can work for you—improving and speeding production. More comfortable and practical than a pencil iron. No transformer required. Price only $5.00.

HEXACON MODEL 30H. Weight 5½ oz. (less cord). 40, or 60 Watts. Both ⅛" and ¼" tips furnished. Ask for literature on complete line of screw tip, plug tip and hatchet irons.

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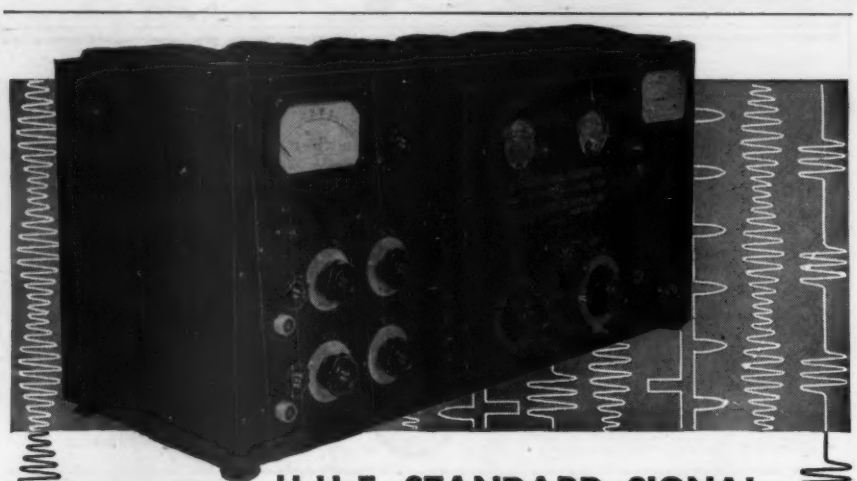


U.H.F. STANDARD SIGNAL GENERATOR *MODEL 84*

Laboratory Standards

SPECIFICATIONS

CARRIER FREQUENCY: 300 to 1000 megacycles.

OUTPUT VOLTAGE: 0.1 to 100,000 microvolts.

OUTPUT IMPEDANCE: 50 ohms.

MODULATION: SINEWAVE: 0—30%, 400, 1000 or 2500 cycles. PULSE: Repetition—60 to 100,000 cycles. Width—1 to 50 microseconds. Delay—0 to 50 microseconds. Sync. input—amplifier and control. Sync. output—either polarity.

DIMENSIONS: Width 26", Height 12", Depth 10".

WEIGHT: 125 pounds including external line voltage regulator.

MEASUREMENTS CORPORATION

BOONTON • NEW JERSEY

ters, since a single authorization can cover a number of associated mobile units. Year-end figures for mobile units are not available.

BUSINESS NEWS

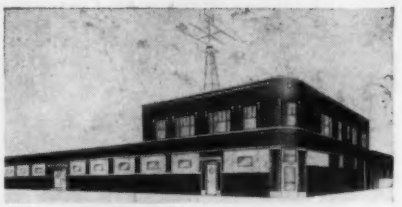
BROCINER - MASS INSTRUMENTS, INC., New York City, has been organized for the development and manufacture of photoelectric colorimeters, photometers and related equipment in the electronic instrument and clinical fields.

MAYFLOWER ELECTRONIC DEVICES, INC., West New York, N. J., has formed a client research department to engage in research on dielectric heat and electronic sealing.

ELTRAN CORP., St. Anne, Illinois, has purchased the business of Radell Corp., Indianapolis, Indiana, to complete its line of loudspeakers.

CUTLER-HAMMER, INC., Milwaukee, Wisconsin, manufacturers of electrical apparatus, has acquired the business of the West Electric Products Co., Los Angeles, Calif.

COOK RESEARCH LABORATORIES, Chicago, Ill., has begun construction of a one-story addition to its present facilities. The new building will



Sketch of new Cook Research Lab

approximately double the floor space available for design, development, instrumentation and testing.

INTERNATIONAL TELEVISION CORP. recently purchased the Minerva Radio Corp. plant at 238 William Street, New York City. The additional 50,000 sq ft of space will facilitate full-scale production of a complete line of television receivers.

AMERICAN STANDARDS ASSOCIATION, INC., is the new name of the ASA New York City. The incorporation recognizes the enlarged activities

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ELECTRICAL & ELECTRONIC
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We Make Complete Equipment For The Manufacture Of Incandescent Lamps Radio and Electronic Tubes.

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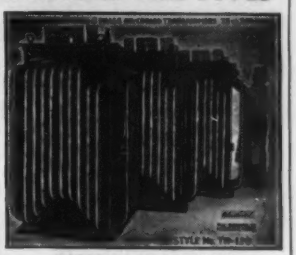

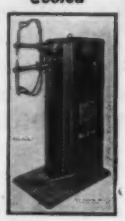

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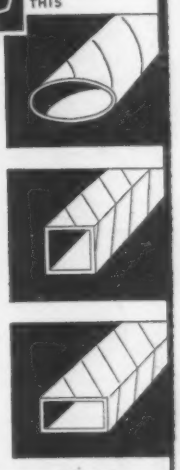
PRECISION

HASN'T "SQUARED THE CIRCLE" BUT HAS "SQUARED THE BOW"



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at no extra cost!

Precision DI-FORMED Paper Tubes have made a most important improvement throughout coil industry. Now ALL coil manufacturers and users can take advantage of the opportunity to obtain Precision DI-FORMED square and rectangular paper tubes for coil bases, *at no extra cost!*

Results: greater strength—automatic stacking—elimination of coil forming after winding—closer engineering of coils, saving wire. Precision characteristics, spiral winding, better insulation, space and weight saving are improved. Tubes also made round, oval, any shape.

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PHOTO-CELL WORK
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LOW LOSS PLUGS AND SOCKETS FOR HIGH FREQUENCY CONNECTIONS. SUPPLIED IN 1 AND 2 CONTACT TYPES:

101 Series can be furnished with ¼", .290", 5/16", ⅜" or ½" ferrule for cable entrance. Knurled nut securely fastens unit together. Plugs have ceramic insulation and sockets have bakelite. Quality construction. Fine finish. Assembly meets Navy specifications.

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Type FI
Type M

Type U

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- TYPE F, contact type, and TYPE FI, with insulated heater, available in ranges of 1.2 milliamperes and over.
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- TYPE U, with insulated heater, for measurements at ultra-high frequencies, made in ranges of 3 milliamperes and over. Streamlined to make convenient use in coaxial cables or fittings possible.
- TYPE R, for radiant energy measurements.

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This book was compiled to answer the need for complete and clear information on the application and design of industrial electronic equipment. Written by a group of engineers, each an expert in his particular branch of electronics, the *Industrial Electronics Reference Book* contains the most recent information on the subject. The material is directed at the practicing engineer. Its aim is to give him a better understanding of the scope and limitations of electronic apparatus as it is applied to industrial processes.

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An extremely sensitive amplifier type instrument that serves simultaneously as a voltmeter and high gain amplifier.

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Also MODEL 45
WIDE BAND
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A few of the many uses:

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and responsibilities of the organization.

PICKARD & BURNS, INC., consulting engineers, recently moved to new quarters at 240 Highland Ave., Needham, Mass.

GENERAL INSTRUMENT CORP., radio and television components manufacturer, is now controlled by a group headed by C. Russell Feldman, founder of Transitone, and Richard E. Laux, formerly vice-president in charge of operations of Colonial Radio Corp., Buffalo, N.Y.

GENERAL ELECTRIC CO., Electronics Park, now has a new division called the Industrial and Transmitting Tube Division. It will consolidate all sales, design engineering and manufacturing activities related to the former Power Electronics Division.

SPERRY PRODUCTS, INC., manufacturers of ultrasonic instruments and hydraulic remote controls, have moved from Hoboken, N. J., to new quarters in Danbury, Conn.

GENERAL ELECTRIC X-RAY CORP., Milwaukee, Wisc., has furnished a two-million-volt x-ray machine for The Babcock & Wilcox Company to examine welds in high-pressure, high-temperature boiler drums 4½ to 6½ inches thick. The machine's exposure time for a 5½-inch plate is 6 minutes when using a film distance of 6 feet. It is the first of its size to be used exclusively for testing welds in pressure vessels. The special new 70 by 30-ft building in which it is housed will accommodate drums up to 13 ft in diameter and 70 ft long.

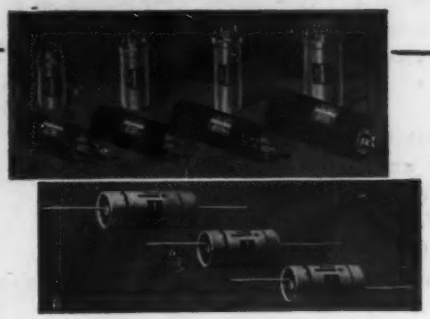
WHEELCO INSTRUMENTS CO. recently opened a new office at 138 East Becher St., Milwaukee 7, Wisconsin.

PERSONNEL

MARTIN KIEBERT, JR. recently joined Raymond Rosen & Co., Philadelphia, to take charge of the engineering, design and sale of all telemetering equipment.

ELTON W. JONES, formerly assistant professor of electrical engineering

ILLINOIS CONDENSERS BELONG IN THE BEST Electronic Sets



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● Look to Illinois for a complete line of electrolytic capacitors for every electronic application. When you need a capacitor that has superior ability to withstand extreme temperature changes; that's manufactured to exacting specifications; that's time tested through 14 years of high quality production experience—you want an Illinois condenser!

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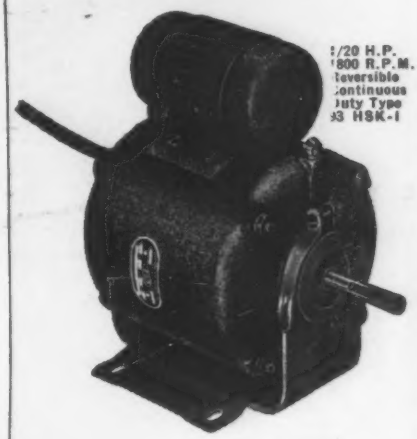
DUAL SPEED HYSTERESIS Synchronous Motors



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Applications:

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We can furnish on quantity orders COMBINATIONS of any two of the following speeds:

600 R.P.M.
900 R.P.M.
1200 R.P.M.
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Instantly reversible with D.P.D.T. switch! H.P. ratings 1/150 to 1/30 depending on speed combination selected. Round Frame, Resilient Mount, Rigid Base.

The hysteresis design of these new Synchronous Motors lowers noise and vibration level to a fraction of that normally present in conventional salient pole construction. Unaffected by load inertia.

These Hysteresis Motors are now standard equipment on many high quality Recorders.

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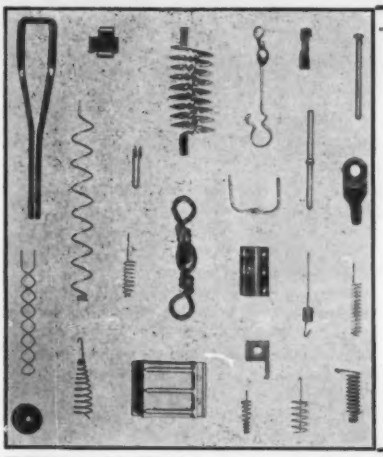

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Filaments, anodes, supports, springs, etc. for electronic tubes. Small wire and flat metal formed parts to your prints for your assemblies. Double pointed pins. Wire straightened and cut diameter up to ⅛-inch. Any length up to 12 feet.

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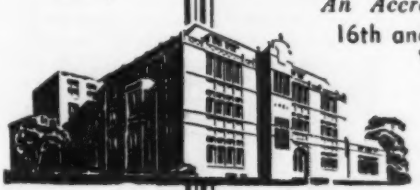

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NEWS OF THE INDUSTRY (continued)

at Pennsylvania State College, was recently named associate professor at Illinois Institute of Technology.

R. JACK WEST, associated with Wired Radio of Canada Ltd. since 1935, was recently appointed vice-president of the company.

CHARLES A. NUEBLING, formerly with Servo Corp. of America and Sperry Gyroscope Co., is now director of electronics for W. L. Maxson Corp., New York City, which recently expanded its engineering activities to include radar and associated high-frequency research and development.

GEORGE M. LEBEDEFF, quality control specialist and formerly chief engineer of Heintz & Kaufman Ltd., has joined Lenkurt Electric Co., San Carlos, Calif., as a carrier engineer.

G. M. Lebedeff

L. Marton

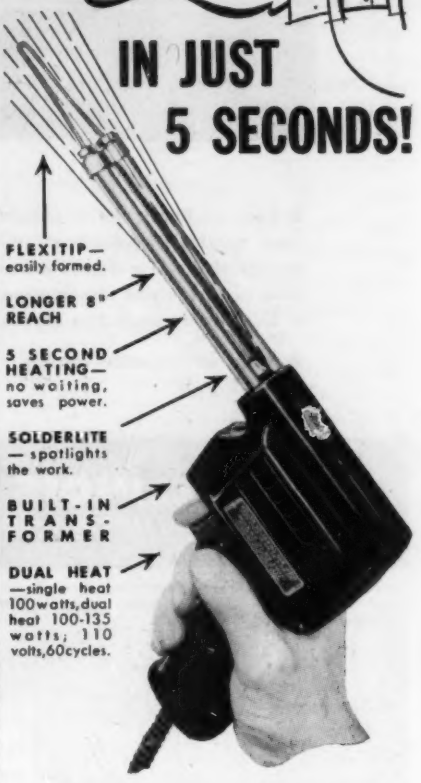
LADISLAUS MARTON, chief of the electron physics section, National Bureau of Standards, has spent the summer in Europe surveying current work in the field of electron microscopy.

LEONARD MILTON, formerly senior engineer at Solar Mfg. Corp., North Bergen, N. J., is now chief engineer at Filtron Co., Inc., Bayside, New York.

HAROLD W. SCHAEFER, until recently in charge of engineering development and research, has been appointed assistant manager of the Westinghouse Home Radio Division, Sunbury, Pa. During the war he was associated with the OSRD in charge of engineering manufacturing of the proximity fuze.

R. W. FERRELL, former counsel for General Electric's Electronics Department at Syracuse, N. Y., has been appointed assistant manager

IN JUST 5 SECONDS!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That's all the time it takes for a Weller Soldering Gun to heat. Pull the trigger switch, make contact, and you solder. Then release the trigger and off goes the heat—automatically. No wasted time. No wasted current. No need to unplug the gun between jobs. The Weller Gun's Flexitip *heats only when in use*—no retinning or redressing when properly used with genuine Weller Tips. This intermittent 5-second heating saves hours and dollars—your Weller Gun will pay for itself in a few months.

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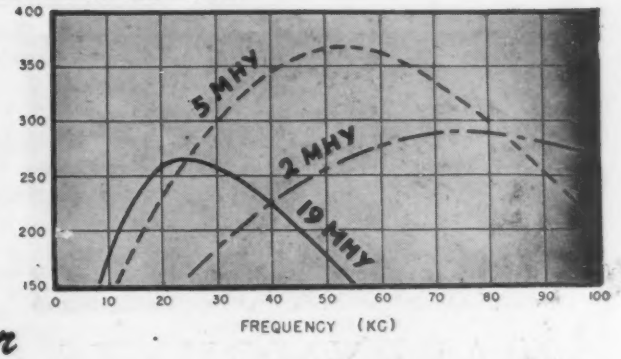

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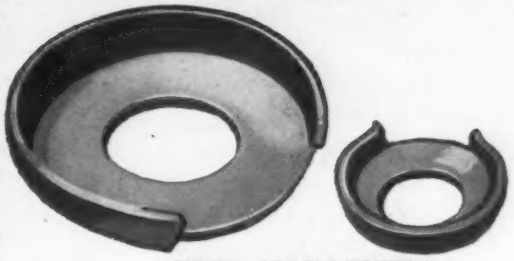

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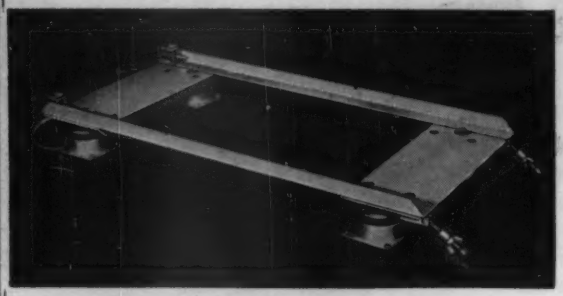

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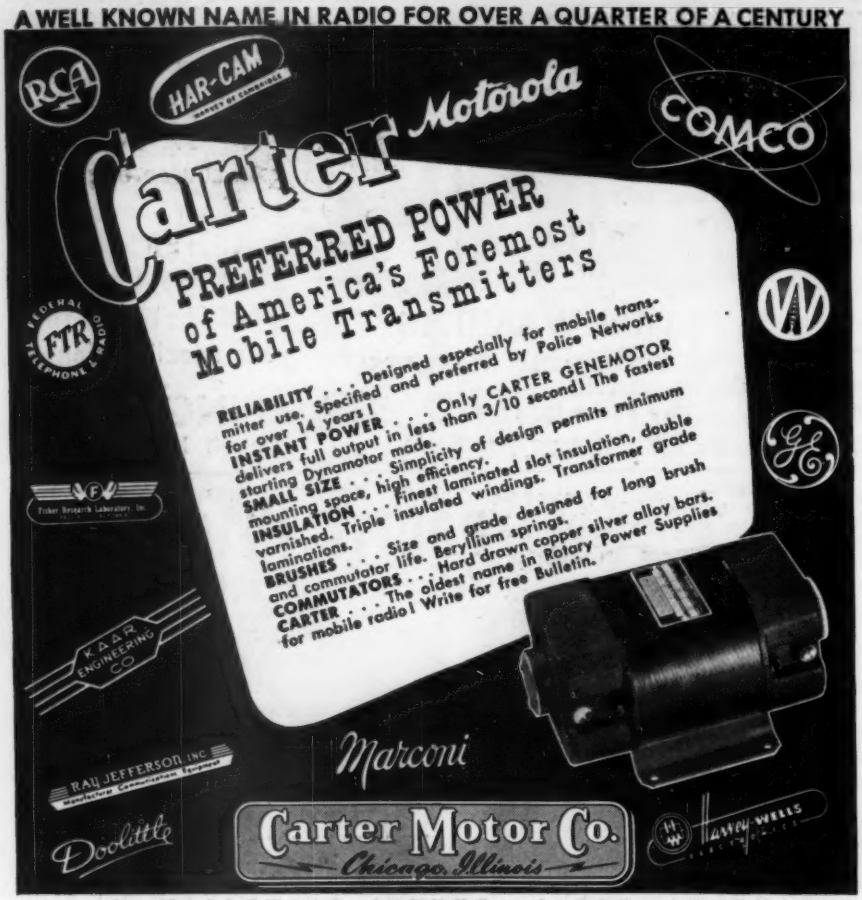
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of the receiver division at Electronics Park.

EDWIN F. STEVENS, formerly chief engineer of International Electronic Laboratories and Lon-Ga-Tone, Inc., is director of sales engineering and research of the newly formed client research department at Mayflower Electronic Devices, Inc., West New York, N. J.

HOBART C. MCDANIEL, formerly commercial engineer with Westinghouse Lamp Division in Bloomfield, N. J., has been appointed manager of the technical press service in the public relations department of Westinghouse Electric Corp., Pittsburgh, Pa.

A. A. EMLEN, formerly vice-president in charge of engineering at American Transformer Co. and then at Newark Transformer Co., has joined the engineering staff of the Peerless Electrical Products Division of Altec Lansing Corp., New York City.

A. A. Emlen

A. E. Cullum, Jr.

A. EARL CULLUM, JR. has been awarded the Presidential Certificate of Merit for meritorious service from August 1942 to February 1946 in his work in radio and radar countermeasures as associate director of the Radio Research Laboratory at Harvard University.

BENJAMIN A. FISHER, formerly professor of electrical engineering at the University of Denver, was recently appointed associate professor at Illinois Institute of Technology.

MAXWELL K. GOLDSTEIN, associated with the Naval Research Laboratory since 1939, has been named to organize and direct the Programs Research Unit of the Research Group of the Office of Naval Research. He holds the Distinguished Civilian

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- Weighs only 3 ounces, yet it can do the job of a 200 watt iron
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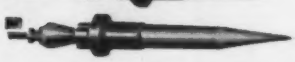

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Service award for his work on the radio direction finder and a commendation from the Chief of Naval Research for his contribution to navigation systems in all-weather flying.

CARL D. PIERSON, JR. has been appointed instructor in electrical engineering at Illinois Institute of Technology. From 1941 to 1948 he was senior engineer and division engineer of the Belmont Radio Corp. in research and development.

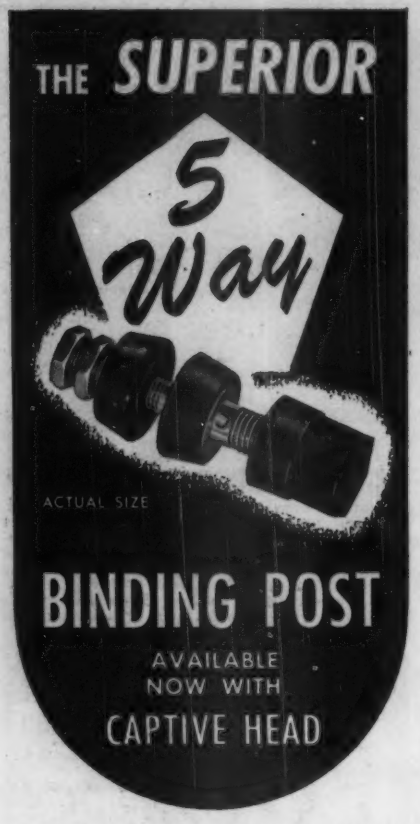
LEANDER W. MATSCH, former supervisor in electrical engineering research at the Armour Research Foundation, is the recently appointed professor of electrical engineering at Illinois Institute of Technology.

A. M. ZAREM, inventor of the Zarem camera used in the photographic microtime technique developed at the Navy Test Station in Pasadena, Calif., has been appointed chairman of physics research and manager of the new Los Angeles Division of the Stanford Research Institute.

RAY DAVIS KELL, director of television research at the RCA Laboratories, Princeton, N. J. was the 1948 recipient of the Stuart Ballantine Medal of the Franklin Institute for outstanding pioneer work in television and for his efforts in the development of color television.

METEOR HUNTER

Electronic metal-detecting wheelbarrow used by H. O. Stockwell for fragments of a meteor reported to have exploded in mid-air in Norton, Kansas



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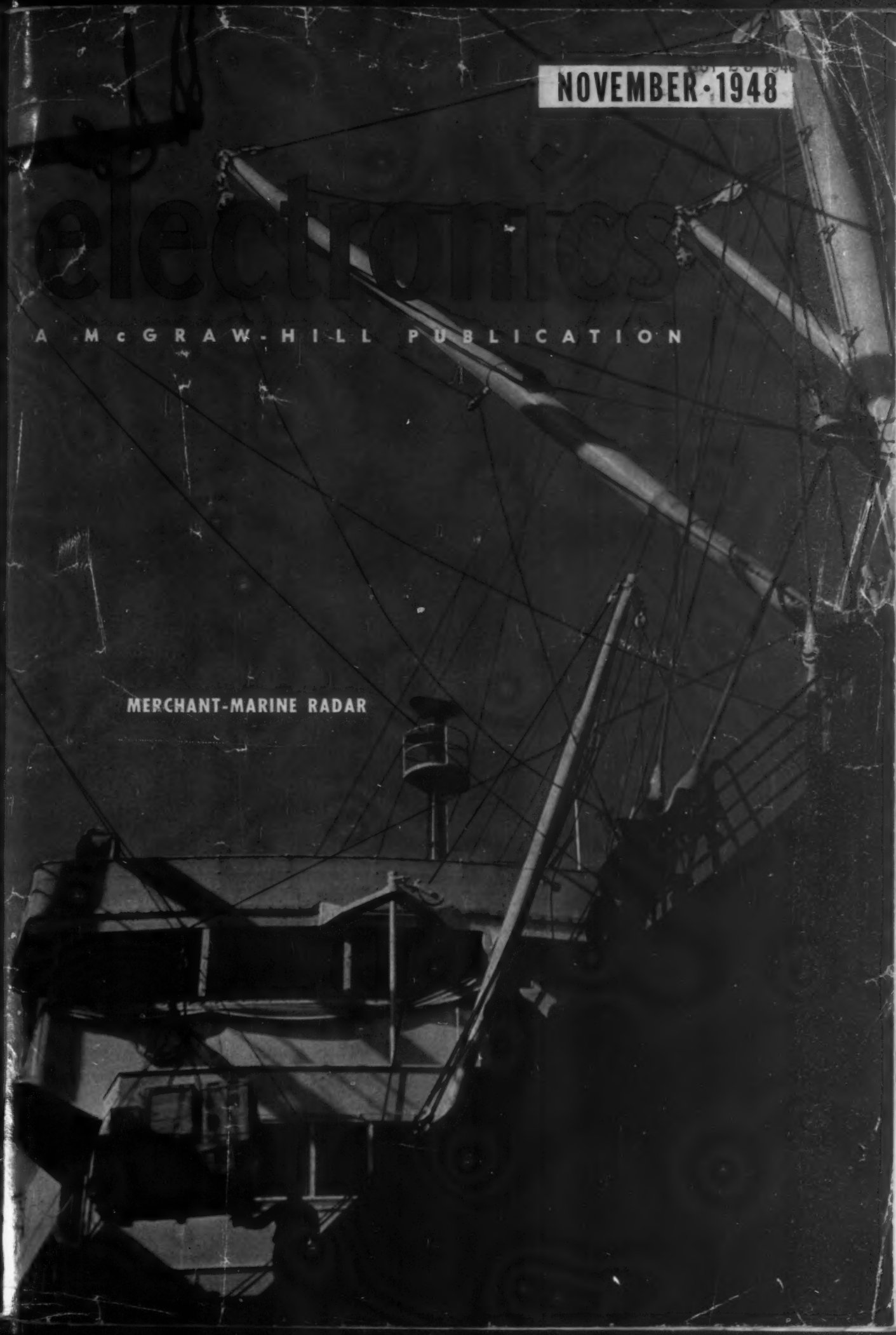

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Type No.	Application	Primary Impedance	Secondary Impedance	± 2 DB from	List Price
A-10	Low impedance mike, pickup, or multiple line to grid	50, 125, 200, 250, 333, 500 ohms	50,000 ohms	30-20,000	$15.00
A-11	Low impedance mike, pickup, or line to 1 or 2 grids	50, 200, 500 ohms	50,000 ohms	50-10,000 multiple alloy shield for extremely low hum pickup	16.00
A-12	Low impedance mike, pickup, or multiple line to push pull grids	50, 125, 200, 250, 333, 500 ohms	80,000 ohms overall in two sections	30-20,000	15.00
A-18	Single plate to two grids	8,000 to 15,000 ohms	80,000 ohms overall, 2.3:1 turn ratio overall	30-20,000	14.00
A-24	Single plate to multiple line	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500 ohms	30-20,000	15.00
A-25	Single plate to multiple line 8 MA unbalanced D.C.	8,000 to 15,000 ohms	50, 125, 200, 250, 333, 500 ohms	50-12,000	14.00
A-26	Push pull low level plates to multiple line	8,000 to 15,000 ohms each side	50, 125, 200, 250, 333, 500 ohms	30-20,000	15.00
A-30	Audio choke, 300 henrys @ 2 MA 6000 ohms D.C., 75 henrys @ 4 MA 1500 ohms D.C., with no D.C. 450 henrys			inductance	10.00

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NOVEMBER • 1948

MERCHANT-MARINE RADAR ..... Cover
Equipment such as this, made by the Sperry Gyroscope Company, assures safe, continuous operation of ships

THE PROSPECTS FOR UHF TELEVISION 68
JTAC report to FCC reveals problems, suggests program

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Sealed plug-in components provide humidity and moisture protection

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Tubes provide instrumentation for rating automotive fuels over the entire speed range

COMPOSITE AMPLITUDE AND PHASE MODULATION, by Oswald G. Villard, Jr. 86
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Twin-source device provides continuously variable flash repetition rate and duration

MOBILE SELECTIVE CALLING, by E. H. B. Bartelink 103
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MICROPHONE CALIBRATOR, by D. H. Bastin 106
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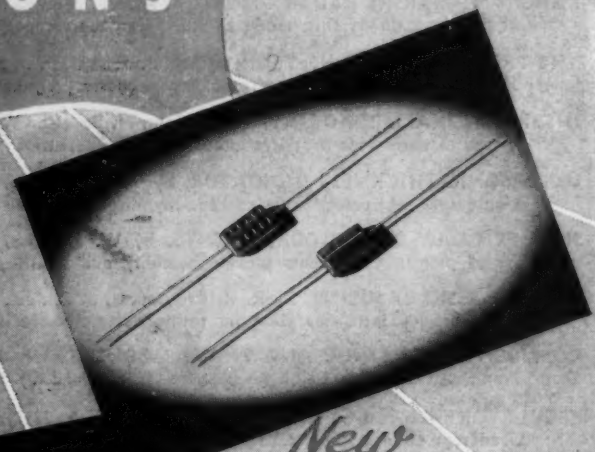

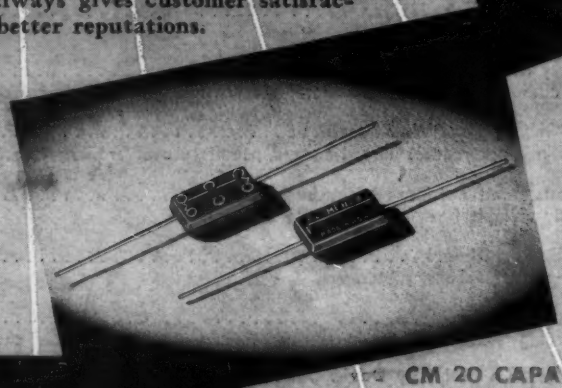

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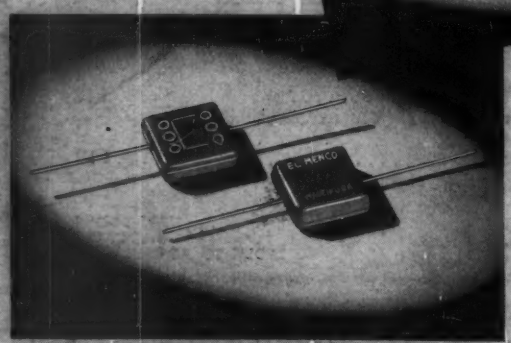

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